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Flakeboard: an Analysis of the Canadian
Market For Sheathing Materials. 1



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FLAKEBOARD
AN ANALYSIS OF THE
CANADIAN MARKET FOR
SHEATHING MATERIALS

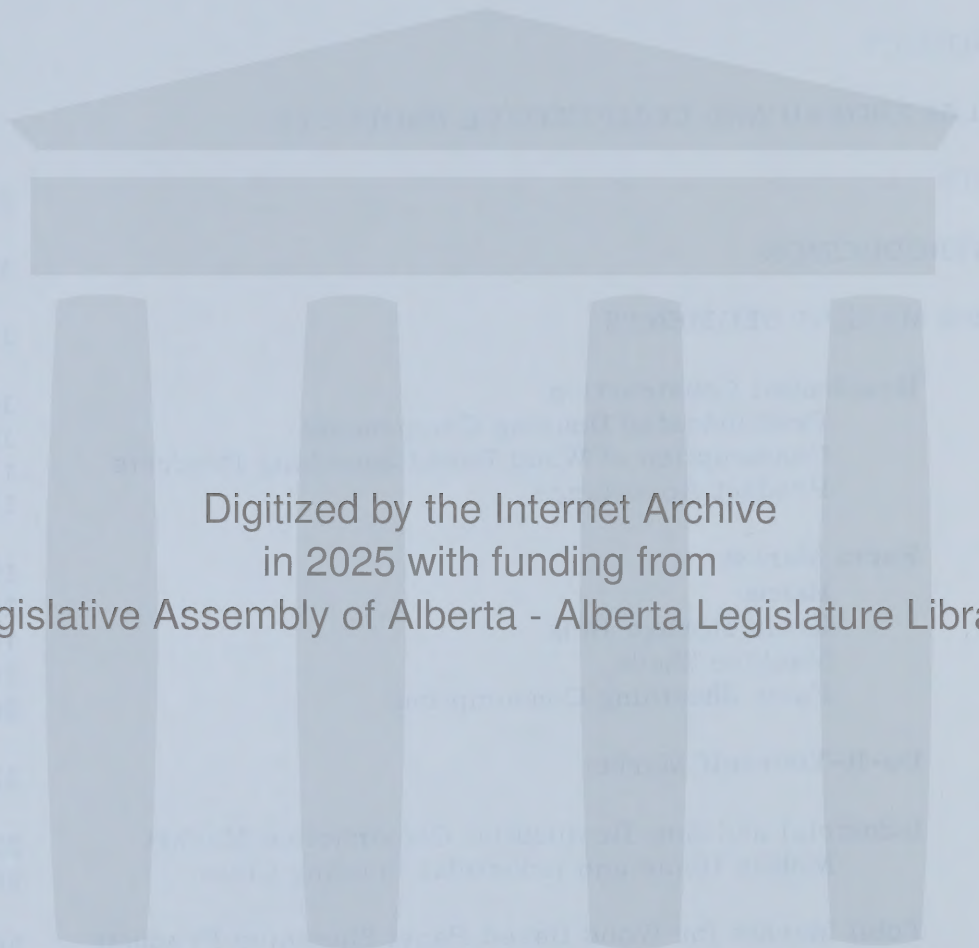
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SUMMARY

This report outlines the markets for phenolic bonded wood wafer board (flakeboard) a substitute product for plywood. Flakeboard is manufactured from Aspen Poplar of which Alberta has vast supplies. At present four major markets consume over 1,200 million square feet of sheathing grade plywood and flakeboard a year. Of this amount only 100 million square feet is accounted for by flakeboard. These markets are:

1. Residential Construction
2. Farm Construction
3. Do-It-Yourself
4. Industrial and Non-Residential Construction

With proper promotion and pricing techniques it is estimated that flakeboard could capture up to 35 per cent of the current and future sheathing market. By 1976 the demand for flakeboard in all markets will exceed 600 million square feet.

In the final section of the report a proposed plant for the Slave Lake area of Alberta is discussed. No firm conclusions, about the establishment of a flakeboard plant in this area, can be drawn without a further study to determine production costs.

INTRODUCTION

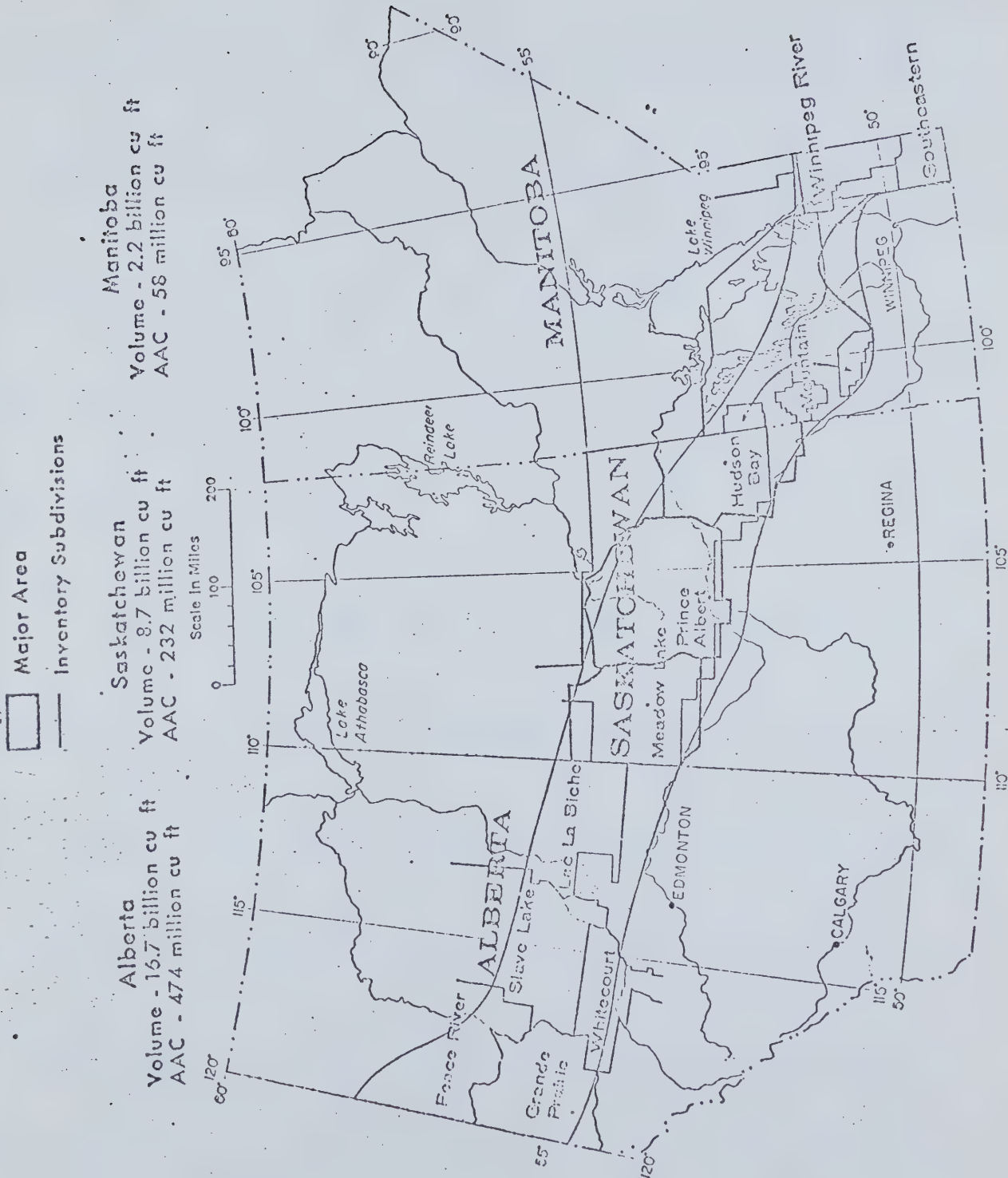
This report studies the Canadian market for phenolic bonded wood wafer board. This board is composed of poplar flakes of engineered dimensions bound with a highly waterproof resin, usually phenol-formaldehyde, under controlled heat and pressure. Phenolic bonded wood wafer board is not composed of waste material, rather the poplar resource is logged specifically for the production of the product. For convenience the product will be referred to as flakeboard in this study.

THE POPLAR RESOURCE

Poplar is found throughout the forest zone of Canada. About 47 per cent of the total Canadian poplar resource is found in the three Prairie Provinces with Alberta accounting for the largest volume, about 23.6 billion cubic feet of net merchantable poplar (gross volume less the volumes for tops and stumps). At present the cull allowance for flakeboard in Alberta is not known. The following map shows the major poplar areas of Western Canada. The Alberta portion outlined accounts for 91 per cent of the total poplar volume in the province. Poplar has an estimated allowable annual cut in Alberta of 478 million cubic feet, the largest of any province and representing almost one-third of the annual allowable cut for all of Canada.

It is estimated that the annual commercial use of poplar in Alberta amounts to less than 5 per cent of the total allowable annual cut of net merchantable poplar. Although the poplar resource in Alberta has only been used to a very limited extent, the economic value of the species is beginning to be recognized and the future should see increasing utilization of poplar.

MAJOR POPLAR AREAS OF WESTERN CANADA



In 1967, Underwood McLellan & Associates Limited completed a study, "Poplar Wood Products Market Survey," for the Alberta Department of Industry and Commerce which noted that a flakeboard similar to MacMillan Bloedel's Aspenite was one product that exhibited opportunities for development and production in Alberta from poplar wood. The present report studies in more detail the market potential for such a product. An analysis of the market by region and by use is included as well as a discussion of the pertinent marketing factors that determine the potential market.

The purpose of this report is to encourage the utilization of Alberta's poplar resources in order to expand the forest industry base of the province and to provide employment opportunities in the prime poplar growing areas of the Lesser Slave Lake region.

REPORT OUTLINE

The information summarized in this report was gathered from the following sources: interviews with a large number of manufacturers and distributors of wood products, retail/wholesale lumberyards, building contractors, and manufacturers of mobile homes and industrial housing units; Wood Products Branch, Federal Department of Industry, Trade and Commerce; Forest Economics Research Institute and Forest Research Laboratory, Federal Department of Fisheries and Forestry; Department of Regional Economic Expansion; Central Mortgage and Housing Corporation; Statistics Canada; Council of the Forest Industries; Alberta Bureau of Statistics; Alberta Department of Lands and Forests; Transport Research and Development Division, Alberta Department of Industry and Commerce; and selected periodicals, reports and studies on the wood products industry.

THE PRODUCT

FLAKEBOARD AND COMPETITIVE PRODUCTS

The product of concern in this report is a dimension flakeboard panel composed of engineered Aspen poplar flakes bonded together by phenol-formaldehyde under pressure. It competes with other waterproof sheathing materials presently on the market.

The product must meet all the requirements of the Type I Particleboard classification of the Canadian Standards Association, CSA 0188, "Mat-formed Wood Particleboard". This standard specifies the requirements for various physical and mechanical properties and the test methods for evaluating these properties. Moreover it provides a national standard of quality for mat-formed wood particleboard presently manufactured in Canada in accordance with the principal demands of the trade. A copy of this standard can be found in Appendix II of this report. Flakeboard must also conform with the requirements of the National Building Code and the Central Mortgage and Housing Corporation and other money lending agencies.

There are two distinct types of sheathing material; planking and panel boards. Planking is generally available in five common widths, and one thickness 1" x 4", 1" x 6", 1" x 8", 1" x 10" and 1" x 12". Panel board sheets come in varying thicknesses, 1/4" to 3/4", and are generally 4' in width and 8' in length. Five types of panel sheathing are available in the market place:

1. Plywood
 - (a) Douglas Fir

- (b) Spruce
 - (c) Poplar
 - (d) Other
2. Building board panels
 3. Asphalted sheathing board
 4. Gypsum sheathing
 5. Flakeboard

The increase in usage of panel board has to a large degree been at the expense of planking. Originally planking was used as a sheathing material but as the price of labour rose, the larger contracting firms began switching to plywood. Although it was slightly more expensive, the 4' x 8' sheets of plywood could be put in place in less time than planking thus resulting in overall savings. Once the larger contractors started using plywood it was just a matter of time before the smaller contractors also switched.

Plywood did not rise to prominence over night. As is the case for many new products, its introduction initially met a fair degree of user resistance. This resistance was gradually broken down as the economic advantages of plywood became obvious and tradesmen became accustomed to working with a different material. Also, plywood has been heavily promoted and this has contributed to its acceptance.

The transition from planking to plywood is still taking place in some areas of the country. As a general rule the use of planking for sheathing purposes is common in those parts of the country which have sawmills situated close to large markets. Thus, planking is still commonly used in both

British Columbia and Alberta. The use of planking now is normally restricted to sub-flooring and roofing. Construction practices and economic conditions also have some bearing on whether or not planking will be used for sub-flooring. In some areas of the country and particularly in Manitoba, Saskatchewan, and Alberta the basement for single family dwellings will be dug, the foundation poured, and the sub-flooring laid; and further construction will not take place until a buyer has been located. The time between the laying of the sub-flooring and the location of a buyer can exceed three months. During this time the sub-flooring is exposed to the elements. If plywood is used for sub-flooring it is subject to checking and warping. For this reason planking is generally used. If the floor is to be enclosed with walls and roof within a short period of the laying of the sub-flooring then plywood is generally used.

The production of softwood plywood is dominated by four large firms: MacMillan Bloedel Ltd.; Crown Zellerbach Canada Ltd.; Weldwood of Canada Ltd.; and Canfor Ltd. These four firms account for about 75 per cent of the total Canadian softwood plywood production. In addition to dominating the production of softwood plywood, they dominate the distribution of a wide variety of building products, utilizing their own distribution systems across Canada. This factor obviously results in formidable competition to any manufacturer not gaining distribution through their well-established channels.

Canadian production of softwood plywood, mainly fir and spruce, has been increasing at about 5 per cent per year. In 1970, production reached approximately 1.9 billion square feet on a 3/8" basis. Of this amount about 21 per cent was exported, mostly to Great Britain. These exports were gen-

erally of higher grade plywood. The following table presents Canadian softwood plywood production and export statistics.

TABLE 1
SOFTWOOD PLYWOOD PRODUCTION AND EXPORTS -
CANADA - 1961 - 1970

(MMSF 3/8" Basis)

<u>Year</u>	<u>DOUGLAS FIR</u>		<u>SPRUCE</u> ¹		<u>TOTAL SOFTWOOD</u>	
	<u>Production</u>	<u>Exports</u>	<u>Production</u>	<u>Exports</u> ²	<u>Production</u>	<u>Exports</u>
1961	1,011	121	49	-	1,061	121
1962	1,096	153	65	4	1,161	157
1963	1,157	180	112	7	1,269	187
1964	1,294	270	151	13	1,445	283
1965	1,456	310	197	15	1,653	325
1966	1,505	354	245	17 ₃	1,750	371
1967	1,571	419	277	24 ₃	1,848	443
1968	1,623	450	322	26 ₃	1,945	476
1969	1,619	436	373	29	1,992	465
1970	1,440	368	405	18	1,845	386

1. From 1961 to 1964 includes Hemlock, Spruce Pine and other; from 1965 to 1970 includes Spruce and Pine.

2. From 1962 to 1966 includes Hemlock, Balsam, Spruce, Pine and other.

3. Estimated Alberta Bureau of Statistics.

Source: Statistics Canada, Catalogue No. 35-001

Imports of plywood during the last decade have been minimal. There is no established market in Canada for imported sheathing grade plywood. According to those in the industry plywood is imported into Canada from the United States only when the price of plywood in Canada is 15 per cent higher than in the United States. In 1970, 12 MMSF of softwood plywood were imported into Canada. Imports in 1969 reached an all time high of 68.5 MMSF. Prior to this time imports of plywood were generally less than 5 MMSF.

With the exception of Douglas Fir plywood, nearly 100 per cent of the Canadian plywood shipments are used for sheathing purposes. Douglas Fir plywood has other end uses such as interior panelling and cement forms. Therefore, it is necessary to estimate the amount of Douglas Fir plywood that is used as a sheathing material. The following table shows domestic shipments of all grades of Douglas Fir plywood from 1961 to 1970, and the estimated amount that was sheathing grade.

TABLE 2

ESTIMATED SHIPMENTS OF DOUGLAS FIR
PLYWOOD - SHEATHING GRADE CANADA 1961-1970
MMSF (3/8" Basis)

Year	¹ Domestic Shipments of All Douglas Fir MMSF	² Approximate Percentage Sheathing Grade %	Domestic Ship- ments of Sheathing Grade Douglas Fir MMSF
1961	896	39	352
1962	939	41	385
1963	958	43	410
1964	1,023	45	455
1965	1,123	46	519
1966	1,120	48	538
1967	1,130	50	562
1968	1,223	52	630
1969	1,159	53	617
1970	1,101	55	605

1. Source: Statistics Canada, Catalogue No. 35-001

2. A report entitled, "A Study of the Canadian Plywood Market in 1962" prepared for the Plywood Manufacturers Association of British Columbia determined that 41 per cent of all plywood used was unsanded (sheathing grade). Those knowledgeable in the industry stated that in 1970 55 per cent of all fir plywood was sheathing grade. Therefore, it may be assumed that the split between sheathing grade and sanded grade fir plywood increased by a percentage of approximately 2 annually from 1961 to 1970.

As can be seen from this table the amount of sheathing grade Douglas Fir plywood has been increasing steadily since 1961. The main reasons for this are the lack of good peeler logs and the introduction of substitute products for sanded plywoods. Large diameter peeler logs are required for the production of sanded grade plywoods at reasonable cost. As the diameter of peeler logs available for the production of plywood becomes smaller, more sheathing grade plywood will be produced. Matformed fibre board panels, which are generally made from waste materials, can be produced cheaper and have the same end uses as much of the sanded grade plywood. For these reasons the percentage of sheathing grade Douglas Fir plywood to total production will probably increase at a steady rate during the next decade.

Flakeboard competes directly with sheathing grade plywood. Other panel sheathing materials such as building panels, asphalted sheathing board, and gypsum sheathing do not compete directly with wood based sheathing products because of price and other considerations. The price of such products is up to half less than the price of plywood or flakeboard. Likewise, the nature of these products affects their use patterns. For example, building board is a general purpose insulating board used in a variety of applications but mainly as an interior wallboard. Asphalt impregnated sheathing is a structural insulation board often used as a wall sheathing in frame construction. An asphalt coating or an integral asphalt treatment is given the board in order to make it waterproof. Asphalted sheathing is more widely used in Ontario and Quebec than in other parts of the country because of construction practices, local laws, price, and consumer acceptance in these areas. However, these

products have very little impact strength and extreme care must be taken to avoid punching holes in the panels while they are being moved or worked with. For this reason such sheathing materials are not as commonly used for factory prefabricated housing sections as are the solid wood based sheathing panels.

Solid flakeboard panels have a number of uses. The largest potential market is residential building construction where flakeboard can be used for wall sheathing, roof sheathing, and sub-flooring. The product is also used in the construction of mobile homes, industrial housing units, vacation cottages, barns, sheds, and other similar structures. In addition, such panels are commonly used by home handymen for fences, patio shelters, and for a variety of other applications.

Flakeboard, unlike plywood, has no grain. Therefore, it can be put in place without worrying about which way the grain is running. This eases the application effort. Another advantage of flakeboard is that the manufacturing process allows odd-length panels to be produced at only a slight increase in cost. Both flakeboard and plywood are normally manufactured in panels measuring 4' x 8', however, other sizes are sometimes in demand. Panels measuring 4' x 4', 4' x 10', 4' x 12', and 4' x 16' have various end uses. Plywood panels with these dimensions command a large price premium, far more than is the case with similar flakeboard panels.

At the present time MacMillan Bloedel Ltd. is the only producer of flakeboard (phenolic bonded wood wafer board) in Canada. They manufacture flakeboard under the trade name of Aspenite in their plant at Hudson Bay,

Saskatchewan and market this product across Canada through their own distribution system. Aspenite is also marketed in the United States in limited quantities; some by MacMillan Bloedel and some by the Blanden Paper Corp. The Blanden Paper Corp. is building a large plant in Michigan to produce a similar flakeboard, and is presently selling MacMillan Bloedel's Aspenite for product introduction purposes.

A second flakeboard plant is currently under construction in Canada at Timmins, Ontario. This plant, owned by the Wafer Board Corp., is to come into production early in 1973, and, although it will have a relatively low production capacity, the total supply of Canadian flakeboard will be increased by about 30 per cent. More significantly because of its location the plant could provide severe competition in the large eastern markets for future firms located in Western Canada. The impact of the Wafer Board Corp. will likely depend on two basic factors: (1) their ability to keep production costs down with a relatively low capacity; and (2) the size of the potential market, which will largely be determined by the volume of residential construction activity and the competitive ability of flakeboard against such established sheathing materials as softwood plywood.

Aspenite has proven to be a valuable addition to MacMillan Bloedel's product line. The success of the product is evidenced by the fact that production capacity has been tripled to approximately 85 MMSF (3/8" basis) at their plant in Hudson Bay and by the fact that other plants are now under construction to produce a similar product. Although larger volumes of the product will soon be on the market, the potential market is large enough to consume far more than can be presently supplied.

MARKETS

INTRODUCTION

During the past decade the use of panel board as sheathing material has shown a dramatic increase. Future increases will be less pronounced and will reflect general economic conditions. Table 3 shows the trend of panel board sheathing consumption in Canada over the past ten years.

TABLE 3

TOTAL PANEL BOARD SHEATHING CONSUMPTION IN
CANADA - 1961 - 1970 VOLUMES BASED ON AVERAGE
THICKNESS AS USED FOR STATISTICAL REPORTING

MMSF								
	Douglas Fir Sheathing	Spruce Sheathing	Poplar Plywood	Building Board Panels	Asphalted Sheathing Board	Gypsum Sheathing	Flakeboard ¹	Total
Year	(3/8")	(3/8")	(3/8")	(1/2")	(1/2")		(3/8")	
1961	352	49	108	57	84	12	N/A	662
1962	385	60	110	55	91	10	N/A	711
1963	410	103	124	59	101	12	N/A	809
1964	455	141	137	62	114	12	N/A	921
1965	519	188	126	57	102	14	28	1,034
1966	538	242	139	50	101	15	40	1,125
1967	562	270	148	49	116	17	50	1,212
1968	630	342	123	53	122	18	55	1,343
1969	617	360	117	55	138	22	57	1,366
1970	605	430	125	51	131	20	65	1,427

1. Directory of the Forest Products Industry,

N/A - Not Available

Source: Statistics Canada, Catalogue Nos. 35-001, 36-002, 44-004.

As Table 3 indicates, spruce plywood has made dramatic gains as a sheathing material. In 1961 spruce sheathing accounted for only 7 per cent of total panel board sheathing consumption in Canada, but by 1970 it accounted for 30 per cent of this growing market. In sum, plywood and flakeboard accounted for 86 per cent of total panel board sheathing consumption in Canada

in 1970. The percentage of building board panels, asphalted sheathing board, and gypsum sheathing consumed in Canada as a percentage of total consumption has decreased from 23 per cent in 1961 to 14 per cent in 1970. The market for plywood and flakeboard will be emphasized in the following sections of this report, with little consideration given to the other sheathing panel products.

THE MARKET SEGMENTS

There are four readily identifiable market segments for wood based sheathing panels in Canada. These are:

1. Residential Construction
2. Farm Construction
3. Do-It-Yourself
4. Industrial and Non-Residential Construction

It is estimated that in 1970 the consumption pattern was as follows:

TABLE 4

CONSUMPTION OF SHEATHING GRADE PLYWOOD AND
ASPENITE, BY MARKET SEGMENT-CANADA, 1970

<u>Market Segment</u>	<u>MMSF</u> (3/8" Basis)	<u>%</u>
Residential Construction	331	27
Farm	135	11
Do-It-Yourself	306	25
Industrial and Non-Residential	453	37
Total All Markets	1,225	100

Source: Alberta Bureau of Statistics

The above market breakdown is, at best, an estimate based on other published reports¹ and on information supplied to the writer by those knowledgeable about the industry. While the percentages may vary from year

1. See Page 14 for References.

to year, depending on economic conditions, the figures presented above do give a potential manufacturer a basic indication of the market segments. As may be expected, the consumption patterns also vary from province to province and this will be discussed in more detail under the separate market headings.

Residential Construction

One of the major end uses for sheathing grade plywood is in the residential construction market. The large sheet sizes in which wood based sheathing panels are available have made them particularly desirable for sheathing of various types. They are mainly used for wall and roof sheathing and for sub-flooring. "Residential Standards", which is a supplement to the "National Building Code of Canada", outlines the rules and regulations concerning the use of sheathing materials. Wall sheathing must be used if nailing between framing members is required or if the exterior finishing requires backing. Sub-flooring must be provided beneath the finish flooring if the finish flooring does not have adequate strength to support expected loads. Roof sheathing is always required. "Residential Standards" also notes the specific-

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1. Material Input Survey, Major Characteristics of Housing Units
Started in 1969, Central Mortgage and Housing Corporation,
Head Office, Ottawa, Ontario 1970.

The Use and Production of Construction-Grade Plywood in
Canada, Forest Economics Research Institute, Forestry
Branch, Department of Forestry and Rural Development,
Ottawa, Ontario 1968.

A study of the Canadian Plywood Market in 1962, Executive
Summary, Conducted for the Plywood Manufacturers Association
of British Columbia, Ben W. Crow and Associates Ltd., Van-
couver, British Columbia 1962.

cations and thicknesses required for either plywood or flakeboard sheathing materials.

In 1971 Central Mortgage and Housing Corporation published a report¹ which gave a detailed breakdown of wood products used for constructing residential dwellings in 1969. This report showed that 295 MMSF of sheathing grade plywood was used to construct single and multiple residential dwellings during this year. Of this amount 42 per cent was used for roofing, 13 per cent for walls, 41 per cent for sub-flooring and 4 per cent for other uses. Over 85 per cent of the total sheathing grade plywood consumed was used for constructing single detached dwellings, semi-detached and duplex dwellings, and row housing.

CMHC's study showed that on a per dwelling basis, British Columbia had the highest usage of sheathing grade plywood. The amount used per dwelling unit progressively decreased from west to eastern Canada. Table 1 in Appendix I shows this trend. It is believed that availability, construction practices, and price are the major reasons for this.

British Columbia accounts for 90 per cent of all softwood plywood produced in Canada. Contractors and tradesmen in this province are thoroughly familiar with the product having used it as a sheathing material for a good number of years. The price differential between plywood and other sheathing materials is not as great in British Columbia as it is in both Ontario and Quebec.

Asphalt sheathing is mainly used in Ontario and Quebec. It is cheaper than either plywood or flakeboard but is extremely susceptible to damage.

1. Op. Cit. Material Input Survey, Major Characteristics of Housing Units Started in 1969.

Savings can be illusory especially if damaged wall panels must be replaced before construction can continue. The heat insulating qualities of asphalt impregnated sheathing makes it an attractive product to contractors who build multiple dwellings for rent. Neither plywood nor flakeboard can compete with this quality.

Prefabricated Housing Components:

There is a slight trend towards the use of such factory built housing sections as exterior walls and roof trusses. There was no agreement among contractors as to whether or not the trend was towards prefabricated sections; some claimed it was the coming thing, others thought it was a passing fad. Those who used prefabricated sections cited lower costs, more control, and fewer sub-contractors to supervise at the construction site as the main reasons for continuing with this practice. They were generally the larger, more progressive construction firms.

Walls which are factory built and shipped to the job site must be covered with a firm but flexible panel sheathing. Therefore non-wood based sheathing materials are only used sparingly in such cases. Many of those who manufacture prefabricated walls for homes have used flakeboard and found it to be quite satisfactory.

When housing components such as walls are constructed on an assembly line basis using flakeboard as a sheathing material, tradesmen soon become familiar with it and there is little trade resistance. However, when flakeboard is installed on the site and especially at sites where both plywood and flakeboard are being used there is a higher degree of resistance to using

flakeboard. Even this resistance is generally overcome though, once workers have used flakeboard for some time.

Consumption of Wood Based Sheathing Products:

By using the CMHC's "Material Input Survey" which presented data for 1969, and by making a few basic assumptions we are able to estimate 1970 consumption of wood based sheathing products, that is, plywood and flakeboard. It was assumed that 27 per cent of the total wood based sheathing shipments were consumed in the residential construction market in 1970. A comparison of Tables 2 and 3, in Appendix I, indicates that to a large degree this assumption is correct. We have also assumed that the consumption of flakeboard closely parallels the consumption of plywood both by market and area.

The 1970 estimated consumption of both sheathing grade plywood and flakeboard is shown on the following table.

TABLE 5

ESTIMATED CONSUMPTION OF SHEATHING GRADE
PLYWOOD AND FLAKEBOARD USED FOR RESIDENTIAL
CONSTRUCTION IN CANADA 1970

(MMSF 3/8" Basis)

Atlantic Provinces	19.9
Quebec	62.2
Ontario	113.7
Manitoba	14.8
Saskatchewan	13.1
Alberta	36.0
British Columbia	71.1
Canada	330.8

Note: For the purposes of this report it will be assumed that flakeboard has a distribution and use pattern similar to sheathing grade plywood.

Source: Alberta Bureau of Statistics

In 1970 flakeboard represented five per cent of wood based panel boards available for consumption as a sheathing material in all markets. Sixty per cent of all the wood based panel sheathing material used in this market is consumed east of the Manitoba-Ontario border.

Product Acceptance:

Any new manufacturer of flakeboard who wishes to have his product used as a sheathing material in the residential construction market must first have it accepted for use by CMHC. To get this acceptance the product must be tested by a reliable independent engineering firm and prove that it meets the requirements of TYPE 1 Particleboard CSA 0188 "Mat-formed Wood Particle-board". The material that is to be tested must be actual mill production. It cannot be a laboratory sample. The engineering report must then be filed with -

Mr. S.J. Murphy,
Senior Materials Officer,
Buildings Material Department,
Engineering and Construction Division,
Central Mortgage and Housing Corporation,
Montreal Road,
Ottawa, Ontario. K1A 0P7

If the above requirements are met the flakeboard will then be accepted for use as a sheathing material for residential construction.

Farm Market

The farm market represents 11 per cent of the total wood based panel sheathing market. While not large it is a market that is easily identifiable. With proper and selective promotion techniques flakeboard can make substantial inroads into this market segment.

According to farm supply dealers who handle sheathing products, farmers generally prefer to use Fir plywood even though there is a price differential between Fir plywood, Spruce plywood and flakeboard. They are familiar with Fir plywood, know what it can do, and are therefore reluctant to change to other types of sheathing materials. Farm supply dealers felt that this resistance to change could be overcome if distributors of sheathing materials demonstrated to farmers how other types of sheathing materials could be used.

The main farm uses for sheathing materials are:

1. Barns
2. Grain storage bins
3. Machine sheds

Barns:

Barns are generally constructed using sheathing material both inside and outside. The outside is then covered with either asphalt shingles or galvanized metal or both. If flakeboard is used in such a structure good drainage and ventilation must be provided. Some farm supply dealers claim that flakeboard cannot be used for barn sheathing as the moisture that is continually generated tends to deteriorate the flakeboard. They also claim that some animals, especially chickens, will eat their way through flakeboard.

Grain Storage Bins:

The need for grain storage bins is dependent on acreage yields and grain sales. If farmers experience bumper crop conditions in periods of low grain sales the demand for storage bins will be high. Presently both wooden and metal prefabricated bins are available on the market. Because this business

is highly competitive any manufacturer selling bins made of flakeboard would have to demonstrate that they are as good as, or better than, both metal and wooden bins. It would also be necessary to price flakeboard bins lower.

Machine Sheds:

Farm machine sheds are a necessity because of Canada's climatic conditions. Expensive machinery must be protected from the elements if it is expected to last for a number of years. Either plywood or flakeboard can be used as a sheathing material for these sheds. Functionally there is little advantage to using one over the other. However, flakeboard does have a price advantage over plywood.

A proper promotion job will be needed to encourage farmers to use flakeboard rather than plywood.

Farm Sheathing Consumption:

The farm market for wood based panel sheathing materials by province or region for 1970 is shown in the following table.

TABLE 6

ESTIMATED CONSUMPTION OF SHEATHING GRADE
PLYWOOD AND ASPENITE USED FOR CONSTRUCTION ON FARMS
IN CANADA 1970

(MMSF 3/8" Basis)	
Atlantic Provinces	3.0
Quebec	28.7
Ontario	45.3
Manitoba	9.0
Saskatchewan	15.9
Alberta	30.0
British Columbia	2.8
Canada	134.7

Source: Alberta Bureau of Statistics

It was assumed that a reasonable area estimate for the farm sheathing market could be derived from statistics showing the percentage breakdown of the value of farm building construction by province. (See Table 4 in Appendix I) The total farm sheathing market was thus allocated on the basis of this percentage.

Do-It-Yourself Market

The uses for sheathing grade plywood and flakeboard in this market are limited only by the imagination of the individual. However there are a few major end uses including second homes, fencing and indoor panelling. The largest single use in this market is the construction of second homes such as cottages, summer homes and ski chalets. As leisure time increases and incomes rise a growing number of people are building second homes, or renovating their present homes. A smaller amount of plywood or other panel board is used for constructing garages. Flakeboard is particularly well suited for use as an indoor panelling material and as a fencing material. It is normally lower priced than plywood panelling, takes paint easily and can be used as a finishing panel without further preparation.

It was assumed that the do-it-yourself market was distributed across the country on the basis of population. The 1970 estimated Canadian market is presented in the following table.

TABLE 7

ESTIMATED CONSUMPTION OF SHEATHING GRADE PLY-
WOOD AND ASPENITE USED FOR DO-IT-YOURSELF CON-
STRUCTION IN CANADA, 1970

(MMSF 3/8" Basis)

Atlantic Provinces	29.1
Quebec	86.4
Ontario	109.6
Manitoba	14.1
Saskatchewan	13.5
Alberta	23.0
British Columbia	30.6
Canada	306.3

Source: Alberta Bureau of Statistics

This represents 25 per cent of the total wood based panel sheathing market.

Industrial and Non-Residential Construction Market

The largest, but least identifiable, market for wood based panel sheathing materials is for industrial and non-residential construction use. It is estimated that this market accounted for 37 per cent of the total wood based panel sheathing market. Some of the major end uses in this market are:

1. mobile home and industrial housing units
2. shipping containers
3. on site construction uses

Mobile Home and Industrial Housing Units:

The average-sized mobile home is 12' x 60' x 8'. Sheathing material is used to cover the walls, roof and in some cases the floor. This sheathing provides rigidity to the home and allows it to be transported without fear of damage. Manufacturers have used fir plywood, spruce plywood and flakeboard as a sheathing material. Some manufacturers prefer either fir or spruce over flakeboard. If flakeboard is not attached to the walls with a 1/8"

spacing between panels the walls will warp when the panels expand. This problem does not occur with either fir or spruce plywood. Problems of attaching siding materials have occurred when using flakeboard and this is another reason why plywood is preferred. Standard 4' x 8' panels are used for the walls with 4' x 12' panels for the roof and sub-flooring. In some cases a premium must be paid for the 4' x 12' panels. Each mobile home could potentially use 2600 square feet of wood based panel sheathing material. However, in some cases substitute products such as particleboard are used and the average is probably closer to 2000 square feet per unit.

The mobile home industry in Canada, and most notably in Alberta and Ontario, is becoming an important market for sheathing panel products. The following table shows the estimated production of mobile homes in Canada and the estimated wood based sheathing panel market for these units.

TABLE 8

ESTIMATED MOBILE HOME PRODUCTION AND MOBILE
HOME SHEATHING MARKET IN CANADA, 1970

	<u>Units</u>	<u>MMSF</u>
Atlantic Provinces	300	0.6
Quebec	1,400	2.8
Ontario	4,000	8.0
Manitoba	1,000	2.0
Saskatchewan	300	0.6
Alberta	4,500	9.0
British Columbia	500	1.0
Canada	12,000	24.0

Source: Alberta Bureau of Statistics

Industrial housing units are generally smaller than mobile homes being an average size of 10' x 40' x 8'. However, they too, use a large

amount of sheathing material. The major manufacturers prefer to use fir plywood even though it is more expensive. The large manufacturers claim that their sales of these units are based on a quality product rather than price. However, if more manufacturers enter this market and are able to substantially undercut the price of their units because they use less expensive sheathing materials, the major manufacturers would probably be forced to do likewise.

The average industrial housing unit could potentially use 1600 square feet of wood based panel sheathing material. However, because substitute sheathing materials such as particleboard are used the average use is closer to 1300 square feet. Most panels are 4' x 8', however, floor and roof panels are generally 4' x 10' and a premium must be paid for these panels. The Canadian production of industrial housing units and the available sheathing market based on an average of 1300 square feet per unit is shown in Table 9.

TABLE 9

ESTIMATED PRODUCTION OF INDUSTRIAL HOUSING UNITS
AND SHEATHING MARKET FOR THIS PRODUCTION, CANADA
1970

	<u>Units</u>	<u>MMSF</u>
Atlantic Provinces	100	0.1
Quebec	800	1.0
Ontario	400	0.5
Manitoba	230	0.3
Saskatchewan	100	0.1
Alberta	3,000	3.9
British Columbia	270	0.3
Canada	4,900	6.4

Source: Alberta Bureau of Statistics

The market for wood based panel sheathing materials for manufacturing shipping containers is unknown and no attempt was made to estimate it as reliable data on this market does not exist. Those manufacturers who were using plywood for shipping containers felt that flakeboard would not be suitable because it lacks the impact strength that plywood has. However, it was felt that if flakeboard could be covered with a material such as fibre glass or other strength giving material it might prove superior to plywood in terms of cost and life.

On-site construction uses of wood based panel sheathing materials range from construction of industrial and commercial buildings to site hoarding. No attempt has been made to estimate this market as data for estimates are not available.

TABLE 10

ESTIMATED CONSUMPTION OF SHEATHING GRADE PLYWOOD AND FLAKEBOARD USED FOR INDUSTRIAL AND NON-RESIDENTIAL CONSTRUCTION IN CANADA - 1970

(MMSF 3/8" Basis)

Atlantic Provinces	10.6
Quebec	119.1
Ontario	104.7
Manitoba	25.1
Saskatchewan	20.2
Alberta	75.3
British Columbia	98.5
Canada	453.5

Source: Alberta Bureau of Statistics

Table 10 shows the estimated Canadian breakdown of wood based sheathing panels used in the Industrial and Non-Residential Construction Market. This represents 37 per cent of the total wood based panel board sheathing market.

Total Market for Wood Based Panel Sheathing Products

The total market is comprised of the four markets which were previously discussed; residential, farm, do-it-yourself, and industrial and non-residential. Tables 11 and 12 which present the total market picture by segment and province should only be used as an indicator of the volumes used by each segment by province. The totals and percentages shown in the last column on the right of these two tables have a higher degree of accuracy than any other statistics on these tables.

TABLE 11

ESTIMATED DISTRIBUTION OF SHEATHING GRADE PLY- WOOD AND FLAKEBOARD BY MARKET AND PROVINCE OR REGION, 1970

(MMSF 3/8" Basis)

	Residential Construction Use mmsf	Farm Use mmsf	Do-It- Yourself Use mmsf	Industrial and Non- Residential Construction Use mmsf	Total MMSF
Atlantic Provinces	19.9	3.0	29.1	10.6	62.6
Quebec	62.2	28.7	86.4	119.1	296.4
Ontario	113.7	45.3	109.6	104.7	373.3
Manitoba	14.8	9.0	14.1	25.1	63.0
Saskatchewan	13.1	15.9	13.5	20.2	62.7
Alberta	36.0	30.0	23.0	75.3	164.3
British Columbia	71.1	2.8	30.6	98.5	203.0
Canada	330.8	134.7	306.3	453.5	1,225.3

Source: Alberta Bureau of Statistics

TABLE 12

ESTIMATED PERCENTAGE DISTRIBUTION OF SHEATHING
GRADE PLYWOOD AND ASPENITE, BY MARKET AND
PROVINCE OR REGION - 1970

	Percentage				
	Residential Construction Use	Farm Use	Do-It- Yourself Use	Industrial and Non- Residential Construction Use	Total
	%	%	%	%	%
Atlantic Provinces	1.6	0.2	2.4	0.9	5.1
Quebec	5.1	2.3	7.1	9.7	24.2
Ontario	9.3	3.7	8.9	8.6	30.5
Manitoba	1.2	0.7	1.1	2.1	5.1
Saskatchewan	1.1	1.3	1.1	1.6	5.1
Alberta	2.9	2.5	1.9	6.1	13.4
British Columbia	5.8	0.3	2.5	8.0	16.6
Canada	27.0	11.0	25.0	37.0	100.0

Source: Alberta Bureau of Statistics

The above table shows that 60 per cent of the wood based panel sheathing market in Canada is located east of the Manitoba-Ontario border. Because of the market distribution any new manufacturer setting up in Western Canada will not be able to sell 100 per cent of his output in the Western Canadian market. Price competition from other manufacturers, in this market, will force the new firm to sell at least 50 per cent of the plant output in areas other than Western Canada. Barriers to entering the Eastern Canadian market, such as freight rates and price, will be discussed in the "Marketing" section of this report. It should be noted, though, that any markets captured by a new flakeboard plant will probably be at the expense of plywood or at the expense of plywood plant expansion.

THICKNESSES

So far we have discussed markets for wood based panel sheathing materials in terms of millions of square feet on a 3/8" thickness basis. While this method allows for a rational standard approach to the subject it does not show the potential manufacturer the variety of thicknesses that he must produce in order to compete effectively.

Current data on sheathing grade plywood thicknesses are unavailable, however, a study conducted in 1962 for The Plywood Manufacturers Association of British Columbia¹ indicated that 95 per cent of all fir plywood sold had the following thicknesses:

1/4"	14%
5/16"	6%
3/8"	19%
1/2"	11%
5/8"	17%
3/4"	28%

Distributors of plywood indicated that over 80 per cent of the sheathing grade plywood sold is of the following thicknesses:

5/16"	
3/8"	80%
1/2"	
5/8"	

Thicknesses of 5/16" and 3/8" are the most popular and have such end uses as wall and roof sheathing in all markets. Because of its strength the thicknesses of flakeboard vary somewhat from plywood. For instance, residential construction financed by CMHC requires 3/8" plywood roof sheathing or 7/16" flakeboard sheathing. Projects which are not financed by CMHC generally use 3/8" flakeboard for roof sheathing.

1. Op. Cit. A Study of the Canadian Plywood Market in 1962, Executive Summary.

When MacMillan-Bloedel took over the Aspenite plant at Hudson Bay, Saskatchewan, three thicknesses, 1/4", 5/16" and 3/8", accounted for over 90 per cent of the production. It is believed that 1/4" Aspenite made up 40 per cent of the total production. The 1/4" thickness was produced for the individual consumer and advertising campaigns were geared to this market. As Aspenite became acceptable to the consumer other markets opened up for this product. The opening of new markets allowed production to shift from 1/4" thickness to 5/16", 3/8" and 7/16". At present it is believed that approximately 70 per cent of the production of the Saskatchewan plant covers the latter thicknesses. About 25 per cent of the production is 1/4" thickness.

It is believed that any new plant producing flakeboard would have to proceed through the same marketing cycle. One major distributor indicated that the sales distribution of this product would be as follows:

1/4"	40%
5/16"	15%
7/16"	43%
Other	2%

Other thicknesses included 3/8", 1/2", 5/8" and 3/4".

DEMAND FORECAST FOR WOOD BASED SHEATHING PANELS

Over the past ten years the consumption of wood based sheathing panels has grown by approximately 10 per cent per year. However, during the last four years the average rate of growth has slowed to near 6 per cent per year. The following table shows the demand forecast for wood based sheathing panels to 1976:

TABLE 13

DEMAND FORECAST FOR WOOD BASED SHEATHING
PANELS CANADA 1971 - 1976
(MMSF 3/8" Basis)

Based on	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
Regression Analysis of						
a) Value of GNP	1,400	1,507	1,624	1,746	1,888	2,021
b) Value of Total Building Construction	1,313	1,400	1,496	1,603	1,715	1,822
c) Value of Residential Construction	1,277	1,359	1,451	1,542	1,639	1,746
Based on						
a) Per Capita Consumption	1,305	1,394	1,486	1,585	1,693	1,807
Average	1,324	1,415	1,514	1,619	1,734	1,849

Source: Alberta Bureau of Statistics

Value of Gross National Product

The Economic Council of Canada's Sixth Annual Review, Perspective 1975 assumes a GNP growth rate of 7.5 per cent per year. This figures includes 2 per cent per year price increase and a 5.5 per cent per year real growth. It is felt that the projected demand, of 2,021 MMSF by 1976 for wood based sheathing panels based on GNP is unrealistic. This amounts to a growth rate for these products of approximately 10 per cent per year.

Value of Total Building Construction

An annual growth rate of 6 per cent has been assumed for this industry. The demand forecast for wood based sheathing panels using the above growth rate gives a projected demand of 1,822 MMSF by 1976 or 8 per cent increase a year.

Value of Residential Construction

The Economic Council of Canada, in the previously mentioned publication, provides for an annual growth rate of 6.1 per cent in residential

construction. They note that this is considerably above the rate of growth that has been achieved over the last 20 years. Based on this rate sheathing demand would be 1,746 MMSF by 1976.

Per Capita Consumption

In 1961 the per capita consumption of wood based sheathing panels in Canada was 27.9 square feet. By 1970 the consumption had more than doubled to 57.3 square feet per capita. The 1960's were a period of rapid growth for this product. As noted previously it was able to gain markets by replacing planking as a sheathing material. While the saturation point has not yet been reached the rate of growth will certainly be less spectacular in the 1970's. Therefore, the demand for wood based sheathing panels will be 1,807 MMSF by 1976, assuming a 5 per cent per year growth in per capita consumption and an annual Canadian population growth rate of 1.6 per cent.

Most Probable Demand

The following table shows the most probable demand for wood based sheathing panels to 1976. The average annual rate of growth is 7.8 per cent.

TABLE 14

PROBABLE DEMAND FOR WOOD BASED SHEATHING PANELS
CANADA 1971 - 1976
(MMSF 3/8" Basis)

	<u>Volume</u> MMSF
1971	1,300
1972	1,400
1973	1,500
1974	1,600
1975	1,700
1976	1,800

Source: Alberta Bureau of Statistics

MARKETING

INTRODUCTION

Flakeboard is more than a physical product of phenolic bonded wood wafer flakes. It includes many intangibles such as guarantees, installation instructions, credit terms, quality, price, method of shipping and distribution, and promotion. These factors and others will be discussed in detail in the following sections of this report.

THE TOTAL PRODUCT

In a previous section of this report the product was discussed in terms of its physical attributes. In addition to the physical product other services are provided by the manufacturer. These include guarantees, technical representatives, credit terms and branding.

Guarantees

A manufacturer of any item must be able to guarantee that his product will meet certain published standards. Specifications for plywood and flakeboard usually include the following:

1. tolerance - thickness, length, width, squareness and straightness
2. maximum moisture content
3. minimum modulus of rupture and elasticity
4. minimum internal bond
5. minimum hardness
6. minimum screw holding strength
7. maximum linear expansion
8. minimum direct nail withdrawal

9. properties after accelerated aging
10. minimum specific gravity
11. maximum water absorption
12. minimum lateral nail resistance
13. Canadian Standards Association approval

If the product fails to meet the published physical properties the manufacturer must be prepared to not only replace the offending product but to reimburse the customer for costs incurred for re-installing faulty panels. Any producer who fails to do this will not long enjoy the confidence of the market place.

Technical Representatives

Any manufacturer who wishes to increase his market for panel board must have technical representatives in the field. These representatives must be thoroughly familiar with the physical properties of the product and also be able to solve problems encountered in the installation of the panels. For instance, because both plywood and flakeboard are dimensional panels, consumers tend to think of them as being the same and, therefore, install them in a like manner. However, as pointed out previously, flakeboard, when used as a sheathing material, must have a 1/8" spacing between panels to allow for expansion. Plywood does not require this spacing. If the customer is not told of the spacing requirements for flakeboard, warping will result and the quality of the finished product is either reduced or ruined and a customer is probably lost. The technical representative should also be able to suggest new applications for flakeboard. These services are a must for any new producer of flakeboard.

Credit Terms

If a new manufacturer of flakeboard sells his entire output to a forest products distributor credit will not have to be granted. Generally distributors pay their bills within 30 days of receiving the invoice to enable them to take advantage of the 2 per cent discount offered for prompt payment. The distributor is generally the one who extends credit to the next customer down the line. This topic is more fully discussed under the heading "Channels of Distribution".

Branding

A brand name helps the consumer identify the goods or services of one seller or group of sellers and distinguishes them from those of competitors. Branding, therefore, can be a real asset to a manufacturer of wood based panel board sheathing material. The brand name not only distinguishes like products but also assures the customer that he is getting the "total product" which includes both the physical product and the services that go with it.

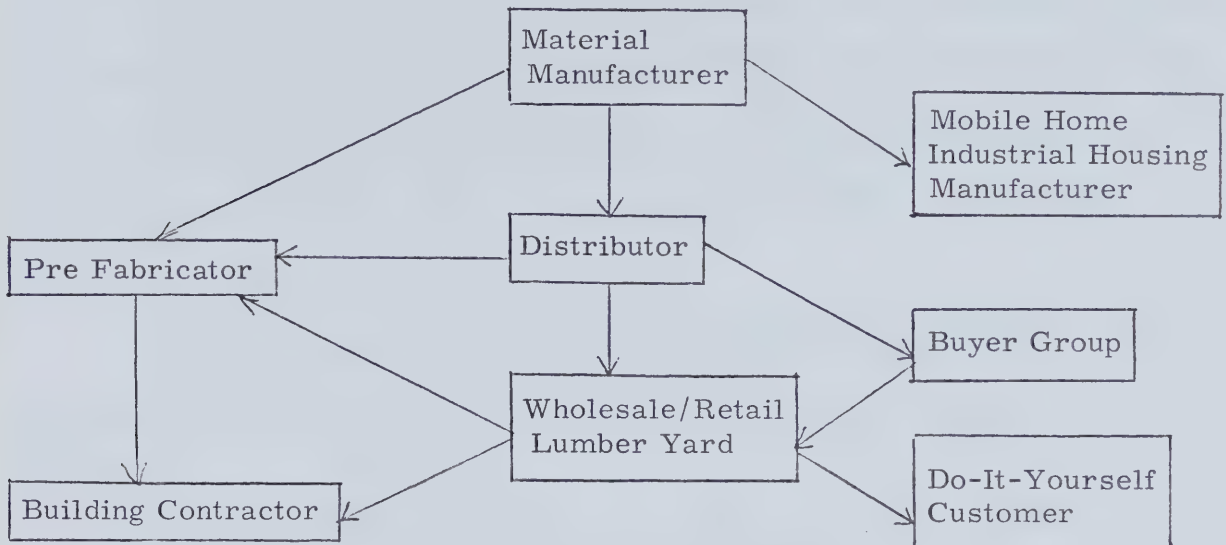
The major advantages of branding to the manufacturer are:

1. a greater chance of success in selling the product
2. allows for independent and recognizable promotion
3. product can be priced independent of competitors' product in some market segments.
4. allows customers to have brand recognition and brand preference
5. dealers often prefer branded products in the hope that the manufacturer's prestige will rub off on the dealer

Probably the major advantage in branding is in the promotional aspect. The manufacturer or his agent can aim promotional material to certain market segments at far less cost and with greater results.

CHANNELS OF DISTRIBUTION

The distribution system for construction materials such as lumber, plywood, wood wafer board, particle board and fibre board is, to a large extent, defined by the end user. The distribution system can be characterized by the following diagram.



This distribution system has evolved because of practices within the industry, and provincial licensing laws. Generally a manufacturer of construction products cannot sell directly to an end user without first obtaining a wholesaler's license. Manufacturer's who do not have control of their own distribution system will normally have their entire output handled by a large national distributor. In this case they will not sell direct to an end user because the end user is also a potential customer for the distributor handling their product. The manufacturer, if he did sell direct, would probably not be able to market his products through a distributor.

The Distributor

The distributor fulfills two important roles in the channel of distribution. He acts as the marketing arm for the manufacturer and as a warehouse for his customers.

The large Canadian wood products manufacturers, MacMillan-Bloedel, Weldwood, Crown Zellerbach and Canfor have their own distributors and warehouses across the country. They basically market their own manufactured products but will distribute products that they do not make themselves for other manufacturers.

These large manufacturers have integrated both horizontally and vertically. Horizontal and vertical integration has the following advantages to the firm:

1. enables it to buy and produce in quantity
2. advertise economically
3. hire top-flight management
4. more ready access to capital
5. smoother co-ordination of activities throughout the system
6. stability of operations
7. assurance of materials and supplies
8. better control of distribution
9. better quality control of products
10. better inventory control
11. prompt revision of production and distribution policies
12. production schedules based on feedback of information

13. reduction of executive overhead expenses

Distributors such as Cooper-Widman, Henderson and the National Association of Independent Building Material Suppliers market products for the smaller manufacturers across the country or on a regional basis. They are in direct competition with the large manufacturers who have their own distributors. However, if the smaller distributor has good market penetration or if one of the large manufacturers has more product than they themselves can sell they will distribute through these smaller distributors.

The distributor has four main customers:

1. original equipment manufacturer (mobile home, and industrial housing manufacturer)
2. prefabricators
3. buyer groups
4. wholesale/retail lumber yard

To service an original equipment manufacturer (OEM) account or prefabricator a distributor must be able to offer the following services:

1. a local supply of materials
2. competitive price

The mobile home and industrial housing markets are extremely competitive. For this reason these manufacturers are price conscious and will quickly switch to less expensive substitute products. A distributor who can supply products at a price three to five per cent cheaper will get the order. Normally, an OEM account will stock no more than two weeks inventory of building materials. Thus a distributor must be able to deliver a supply of materials to him at short notice. This generally means that the distributor must warehouse

wood products locally.

The wholesale/retail lumber yard also expects certain services to be supplied by a distributor.

1. full product line
2. local supply of materials
3. help in product promotion
4. competitive prices

Lumber yards generally carry a full range of products to enable them properly to service their customers. If they are able to purchase their products from one supplier at competitive prices it reduces their costs. Although they will often buy in carload lots (usually shipped direct by the manufacturer but invoiced through a distributor) they still wish to be assured of a local back-up supply. It is therefore important that the distributor warehouses locally.

When a new product is put out on the market the wholesale/retail lumber yard dealer expects either the manufacturer or the distributor to help directly in its promotion. Dealers will not carry products that have poor demand because of the lack of promotion. They are generally receptive to new products and will help in promoting the product of their customers.

It is up to the manufacturer to decide where his product will enter the distribution channel. The point at which he enters will determine his promotion policy. A manufacturer who does not own or control his own distribution system has three options on where to enter the channel:

1. sell his output to one distributor
2. sell his output to a number of distributors

3. sell his output to individual customers at or near the bottom of the distribution channel

If the manufacturer sells his entire output to a single distributor, then, this distributor would share in the cost of promotion. The brand name of the product would be chosen and agreed upon by both the distributor and the manufacturer. The manufacturer would be responsible for employing a representative to handle technical promotion. All other promotional techniques would be handled by the distributor. Normally, a distributor works on a price margin of 5 per cent, however, if he is handling the promotion he would expect to receive an additional 5 per cent discount from the manufacturer to cover these costs. If the product is sold to a number of distributors the manufacturer will be responsible for the entire promotional package.

Entering the channel near the bottom would force the manufacturer to set up his own distribution system. The manufacturer would be responsible for hiring his own sales staff and for the full promotion of the product. In addition he would also have to take the risk of granting credit.

The Wholesale/Retail Lumber Yard

There are four types of lumber yards:

1. those dealing exclusively with building contractors
2. those dealing with building contractors and the do-it-yourself trade
3. those dealing primarily with the do-it-yourself trade
4. those dealing exclusively with the farm trade

The dividing line between the above types of lumber yards is often not clear-cut. Generally, the first type is a subsidiary of a large contracting firm

dealing exclusively in residential construction. The lumber yard buys lumber by the carload lot, warehouses it and ships truck loads of mixed products to the contractor's job site. The mix of products is not as extensive as the other three types of yards.

The fourth type of lumber yard usually has the greatest product mix and deals exclusively with farmers. Companies such as UFA Co-op and Federated Co-op are the types of firms that fall into this category. They usually are wholly farmer owned.

The second and third types of lumber yards plan an important role in the channel of distribution. Those lumber yards which deal with the smaller building contractor must be able to supply the following services:

1. extend a line of credit
2. provide on site delivery of a mix of products
3. good and timely service

Most building contractors in the field of residential construction do not have the capital resources to purchase materials on a cash basis. Lending institutions will not forward money to a contractor until certain phases of construction are completed. This usually means that 30 to 120 days pass from the time the contractor receives his building materials until he can pay for it. This is normally the amount of time a dealer will give a contractor to pay his bills. On the average credit terms are extended for 45 to 60 days after invoicing. A ceiling is usually placed on the amount of credit extended.

Since most contractors dealing with lumber yards are not "tract" builders they require small shipments of different products to the construction

site. These deliveries must be made on schedule and at a competitive price. A dealer who supplies the above services and extends credit has little problem holding his better customers.

The lumber yard which deals with the do-it-yourself trade must be able to supply:

1. service
2. good location
3. large product mix
4. competent advice
5. credit
6. competitive price

As with any retail business all the above points are important. However, the one point which probably guarantees a steady customer is the availability of competent advice. Retailers of building products who know the uses for their products and who are able to give both advice and instructions to the do-it-yourselfer have little trouble in maintaining a good volume of business.

Buyer Groups

Buyer groups are made up of wholesale/retail lumber yards which have banded together to reduce the cost of goods which they purchase. Allont is probably the largest buyer group, representing about 200 lumber yards across the country. They have a central purchasing organization, buy in bulk, and put out a catalogue but they do not warehouse products. Products are shipped direct to each individual yard.

Other buyer groups which operate regionally but not nationally are:

1. Ontario
 - a) Colpo
 - b) Bold
 - c) Aid
2. Quebec
 - a) Dismat
 - b) Pilon
 - c) Union 6
3. Alberta, Saskatchewan, Manitoba
 - a) Tim-br-marts

In some cases these groups have a central purchasing agency; in others they merely name a preferred wholesaler and then police their organization to ensure that all purchasers are made from the preferred wholesaler. The wholesaler must deal with each buyer individually under this scheme. Sometimes the buyer group will extend credit to its individual members to help in purchasing products.

It is estimated that 80 per cent of all plywood sold in Ontario is purchased by buyer groups.

Buyer groups have absolutely no manufacturer loyalty and will switch from one distributor to another if the price is lower. Because of this a manufacturer should be wary of distributing his products at this level.

Prefabricators

The prefabricator generally manufacturers, on an assembly line basis, component parts that are used in residential construction. Such parts as roof trusses and exterior walls are prefabricated and then shipped to the job site.

Most prefabricators are wholly owned subsidiaries of large construction firms. Since the large contractors generally own their own lumber yard the prefabricator is supplied directly by this lumber yard. However, in some cases an independent prefabricator (one which is not owned by a contractor) will, if his purchases are large enough, buy direct from the distributor. He will then expect the same services as the OEM account.

Potential Distributors

A number of national forest products distributors have indicated that they are interested in handling a product similar to Aspenite. Listed below are those who indicated this interest:

Cooper Widman Ltd.,
905 Two Bentall Centre,
Vancouver, B.C.
Attention: J. Loutit

MacMillan Bloedel Ltd.,
1075 West Georgia Street,
Vancouver, B.C.
Attention: F.N. Riddles

Canfor Ltd.,
440 Canfor Avenue,
New Westminster, B.C.
Attention: Mr. M.J. Orr

Weldwood of Canada Ltd.,
1055 West Hastings,
Vancouver, B.C.
Attention: P. Vik

National Association of Independent Building,
Materials' Distributors,
8400 Cote De Liesse Road,
Montreal, Quebec.
Attention: P.M. Graham

FREIGHT RATES

As noted previously if a new flakeboard plant is established in Western Canada 50 per cent of the output will likely have to be sold in market areas other than Western Canada. To reach the Eastern Canadian market, carload lots of flakeboard will have to be shipped to central distribution points in Ontario, Quebec and the Atlantic Provinces. Since up to 25 per cent of the mill selling price, F.O.B. destination, is accounted for by rail freight charges a new manufacturer should be aware of the probable freight rates he will be faced with and the current rate his competitors now pay.

For the purposes of this report we have assumed that the new flakeboard plant will be located in the Slave Lake, Alberta area. There are at present no negotiated rail freight rates out of this area for flakeboard and we have therefore, used the negotiated rates for lumber. Negotiated flakeboard rates would probably be included under the same tariff. While rail rates from Hudson Bay, Saskatchewan to points in Western Canada have been negotiated, most of the flakeboard is trucked to various locations in the west. Truck rates are not available, however, it is believed that they are lower than the rail freight charges.

Any new manufacturer of either flakeboard or plywood would be competing for the same markets as established plants at Vancouver, Hudson Bay, Fort McLeod and Grande Prairie to name a few. Negotiated rail freight rates have been established for these and other centres. The following table shows the freight rates presently in force from these locations to other specified centres across Canada. The rates are based on minimum car loads

weighing 80,000 pounds or more.

TABLE 15

Rail Freight Rates Applicable to Plywood and Flakeboard
(Rates in Cents Per 100 Pounds)

<u>To</u>	<u>From</u>				
	<u>Vancouver</u>	<u>Fort McLeod</u>	<u>Grande Prairie</u>	<u>Slave Lake</u>	<u>Hudson Bay</u>
	<u>B.C.</u>	<u>Alberta</u>	<u>Alberta</u>	<u>Alberta</u>	<u>Saskatchewan</u>
Edmonton	79	-	-	21	94*
Calgary	65	-	-	38	100*
Regina	110	-	-	65	53*
Saskatoon	110	-	-	47	53*
Winnipeg	139	-	112	89	76*
Toronto	148	149	148	148	127
Ottawa	141	141	141	141	133
Montreal	141	141	165	141	133
Quebec	159	144	144	144	133
Halifax	148	148	148	148	161

- Negotiated Rates Not Available

Note: Minimum Shipment of 80,000 Pounds

* Minimum Shipment of 70,000 Pounds

Source: Department of Industry and Commerce, Transport Research and Development Division.

Table 16

Cost Per Ton Mile Based On

Rail Freight Rates Applicable to Plywood and Flakeboard

(Cents Per Ton Mile)

To	Plywood From Vancouver B.C.	Plywood From Fort McLeod Alberta	Plywood From Grande Prairie Alberta	Flakeboard From Slave Lake Alberta	Flakeboard From Hudson Bay Saskatchewan
Edmonton	2.07	-	-	2.51	3.49
Calgary	2.03	-	-	2.91	3.25
Regina	1.99	-	-	2.00	4.33
Saskatoon	2.02	-	-	1.90	4.91
Winnipeg	1.90	-	1.87	1.85	4.01
Toronto	1.10	1.47	1.21	1.34	1.58
Ottawa	1.02	1.35	1.12	1.24	1.59
Montreal	0.98	1.28	1.07	1.18	1.48
Quebec	1.07	1.26	1.06	1.16	1.42
Halifax	0.83	1.02	0.89	0.96	1.29

In almost all cases the cost per ton mile is less out of Vancouver than for the other listed centres. An Alberta manufacturer of flakeboard not only faces higher freight charges but also pays more to ship 1,000 square feet of flakeboard of a given thickness than he would if he were shipping plywood. The weight of 1,000 square feet of flakeboard is about 10% higher than the same amount of plywood of the same thickness.

Table 17 shows the current freight charge for 1,000 square feet of 3/8" plywood shipped from Vancouver and 1,000 square feet of 3/8" flakeboard shipped from the Slave Lake area in Alberta and Hudson Bay, Saskatchewan. Shipping charges for other thicknesses are proportionately higher or lower as the case may be.

Table 17

Rail Freight Rates for 1,000 Square Feet of 3/8"¹

Plywood or Flakeboard Shipped From Specific Points

	Plywood From <u>Vancouver</u> \$	Flakeboard From <u>Slave Lake</u> \$	Flakeboard From <u>Hudson Bay</u> \$
Calgary	7.31	4.75	9.25
Edmonton	8.89	2.63	10.00
Regina	12.49	8.13	5.50
Saskatoon	12.49	5.88	5.50
Winnipeg	15.64	11.13	8.00
Toronto	16.65	18.50	16.25
Ottawa	15.86	17.63	17.13
Montreal	15.86	17.63	17.13
Quebec	17.89	18.00	17.13
Halifax	16.65	18.50	20.63

¹ Freight charges for other thicknesses of fir and spruce plywood and flakeboard may be found by referring to Table 5 through to Table 19 in Appendix I.

A manufacturer shipping from Slave Lake faces higher freight charges than other manufacturers to all places in Canada except Alberta. These freight rates may be lowered somewhat by trucking to points in Western Canada. Therefore, if a manufacturer, located in the Slave Lake area, is to compete effectively his production costs must be such that he can realize an economic return on his investment.

PRICE

Approximately 90% of all plywood consumed in Canada is produced in British Columbia. Because of this, West Coast plywood

mills are generally the price leaders within certain marketing constraints. These constraints are Canadian supply and demand for plywood and United States plywood prices. The price of plywood in Canada can generally float 10 to 15 percent above the U.S. price because of the 15 percent Canadian tariff on imported plywood, freight charges to any specified destination and the premium on either of the currencies. If Canadian prices rise above this differential, U.S. plywood will enter the market.

Plywood mills located outside of British Columbia generally price their products either equal to or slightly lower than that quoted by West Coast mills for any specified destination. Because the West Coast mills are the price leaders, prices quoted in this report have been worked back to Vancouver prices and then freight rates and federal tax have been added back to give an FOB destination price.

Wood based panel sheathing products such as, fir, spruce, and poplar plywood and flakeboard are viewed as being commodities. (i. e. the customer will generally purchase the less expensive product and not be concerned with the differences between the products if both serve his purposes equally well). This is especially true in Eastern Canada. Therefore price plays an extremely important role in the selection of a wood based sheathing product. The following section

deals with the industry pricing practices.

Distributor Selling Price

From time to time the major forest product distributors publish price lists showing the carload lot list price per 1,000 square feet of sheathing grade plywood at specified locations. The list price seldom if ever reflects the true carload lot price. Trade discounts must first be deducted from the quoted price less freight. These discounts are normally quoted as a number of 5% reductions to the above price.

The following example shows the complex nature of this problem. The final price shown reflects the cost per 1,000 square feet of a carload lot of 4' x 8' panels of 3/8" spruce plywood to a customer in Calgary on September 3, 1971. The purchase is assumed to have been made through a distributor.

Table 18

Distributor Car Load Lot Price To Calgary Customer

	<u>Price Per MSF</u>
	\$
List Price (Federal Sales Tax Not Included)	
FOB Calgary	117.71
Less Rail Freight (From Vancouver)	<u>7.31</u>
Base Price	110.40
Less Trade Discounts (Four Discounts	
Of 5% One of 3%)	<u>23.17</u>
Distributor Selling Price (Less Freight	
And Federal Sales Tax)	87.23
Add Federal Sales Tax	12.14
Add Freight Rate Charges	<u>7.31</u>
Price Paid Per MSF By Calgary Customer	106.68

On the above date distributors were giving a discount of four 5% and one 3% from the list price less freight and federal sales tax. These discounts are applied to this price consecutively. For example a product quoted at \$100 per 1,000 square feet (less freight and federal sales tax) would have these discounts applied as follows:

Table 19
Application Of Trade Discounts

				<u>Price Per 1,000 MSF</u>
				\$
Quoted Price (Less Freight and Federal Sales Tax)				100.00
Less Discounts:	5%	<u>5.00</u>		95.00
	5%	<u>4.75</u>		90.25
	5%	<u>4.51</u>		85.74
	5%	<u>4.29</u>		81.45
	3%	<u>2.44</u>		79.01
Actual Price				

To find what the customer pays, the charges for federal tax and freight must be added on to the actual price shown above.

While the above system may seem overly complicated it does give the distributor flexibility in making immediate price changes based on changing market conditions. It also eliminates the necessity of continually publishing or updating price lists.

Table 18 shows the price paid by a Calgary customer for a full carload lot shipment of 4' x 8' panels of 3/8" spruce plywood. This is the lowest price available to any customer purchasing through a distributor. Any customer buying at this price would normally have to purchase a number of carload lots during the year. All shipments to this customer would be direct from the mill. Customers purchasing less than a carload lot would normally receive their sheathing materials from the distributor's warehouse. The price per 1,000 square feet could be upwards of 50% higher. The prices of sheathing grade plywood and flakeboard are higher in Eastern Canada because of increased freight costs.

Net Mill Selling Price

One of the most important prices that must be determined is the net mill selling price per 1,000 square feet of plywood and flakeboard to the distributor from the mill. It is this price that will determine whether or not the mill will be a viable operation.

As mentioned previously it is most unlikely that any new manufacturer of plywood or flakeboard will be able to command a price for his product greater than that now charged by West Coast plywood mills FOB destination. It should also be noted that this distributor selling price of flakeboard in any market is currently 10% less than the price of Spruce plywood per 1,000 square feet. A new manu-

facturer of flakeboard would probably have to maintain a 15% distributor selling price differential in the initial stages of market entry. These restraints must be taken into account when arriving at the net mill price.

The current trade practice allows the distributor to work on a 5% markup plus a 2% prompt payment discount (normally 30 days from invoicing). Thus to compute the net mill price the following formula must be used.

NET MILL PRICE = LIST PRICE - FREIGHT CHARGES -
FEDERAL SALES TAX - TRADE DISCOUNTS - MILL DISCOUNTS

The following example shows the expected mill net back to a spruce plywood mill shipping from Vancouver or the British Columbia interior to a Calgary distributor. The data are based on prevailing rates and prices as of September 3, 1971, for 1,000 square feet of 4' x 8' panels of 3/8" sheathing grade spruce plywood. Carload lot shipments of 80,000 pounds minimum are assumed.

Table 20
Net Mill Price Per 1,000 Square Feet Of 3/8" Spruce Plywood,
Shipment From British Columbia To Calgary
(September 3, 1971)

	<u>\$/MSF</u>	<u>\$/MSF</u>
List Price (FOB Calgary)		129.85
Less: Rail Freight	7.31	
Federal Sales Tax	<u>12.14</u>	
Base Price		110.40
Less: Trade Discounts (4 x 5% and 3%)	23.17	
Mill Discounts (5% and 2%)	<u>6.02</u>	
Net Mill Price		<u>81.21</u>

On September 3, 1971 the selling price of sheathing grade spruce plywood was at a two year high and therefore not indicative. On August 21, 1970 the price was at a five year low. The net mill price at that date amounted to \$61.73 per 1,000 square feet for spruce plywood shipped to a Calgary customer from British Columbia. This is a price spread of some 32%. Tables 5 through to 14 in Appendix I show the net mill price for fir and spruce plywood mills, located in British Columbia, and prices of 4' x 8' sheathing grade panels by thickness and destination.

Table 21 shows the net mill price index for 3/8" sheathing grade fir and spruce plywood FOB Vancouver. The price of sheathing grade fir plywood on July 31, 1969 equals 100. Table 22 shows monthly shipments of softwood and poplar plywood. Total shipments in August 1970 are down by over 8% from the same month in 1969.

Table 21

Net Mill Price Index for 3/8" Sheathing Grade

Fir and Spruce Plywood F.O.B. Vancouver

(Fir Plywood Prices of July 31, 1969 = 100)

	<u>1969</u>		<u>1970</u>		<u>1971</u>	
	Fir	Spruce	Fir	Spruce	Fir	Spruce
January	113	N/A	104	99	92	77
February	113	N/A	96	94	92	77
March	113	N/A	96	94	99	87
April	115	N/A	87	77	99	91
May	115	N/A	87	77	99	91
June	115	N/A	92	81	99	91
July	100	82	92	85	104	91
August	100	82	79	77	104	91
September	95	82	92	77	109	101
October	100	91	92	77	N/A	N/A
November	104	99	92	77	N/A	N/A
December	104	99	92	77	N/A	N/A

N/A - Not Available

Note: Index as at Month End

Source: Alberta Bureau of Statistics

Table 22
Softwood and Poplar Plywood Shipments
By Month Canada, 1969, 1970, 1971

	<u>1969</u>		<u>1970</u>		<u>1971</u>	
	MMSF	%	MMSF	%	MMSF	%
January	125.9	7.4	103.9	6.1	105.5	
February	127.5	7.5	121.3	7.1	143.7	
March	154.6	9.2	153.1	8.9	150.9	
April	159.7	9.4	191.2	11.1	156.4	
May	160.3	9.5	155.3	9.0	152.7	
June	136.5	8.1	164.9	9.6	182.3	
July	137.5	8.1	129.0	7.5	164.1	
August	140.1	8.3	129.3	7.5	161.4	
September	141.1	8.3	145.4	8.5	185.0	
October	142.8	8.4	158.5	9.2	N/A	
November	141.0	8.3	142.2	8.3	N/A	
December	127.3	7.5	124.1	7.2	N/A	
Total	1,694.3	100.0	1,718.2	100.0		

N/A - Not Available

Source: Statistics Canada, Catalogue No. 35-001

Tables 15 to 19 in Appendix I show the net mill prices for a theoretical plant located in the Slave Lake area of Alberta. The net mill prices are calculated for the low and high selling prices mentioned previously. These net mill prices were calculated using the following assumptions.

1. Flakeboard is priced 10% below spruce sheathing grade plywood of equal thickness.
2. The price of spruce plywood FOB destination is equal to the FOB price Vancouver plus freight to that destination from Vancouver.
3. The net mill price is equal to the price in (2) above less the freight to that destination from the Slave Lake area.
4. That all shipments are made in carload lots by rail (shipments to destinations in Western Canada will probably be made by truck and at slightly lower cost. This tends to understate the net mill price for shipments to Western Canada)

PROPOSED FLAKEBOARD PLANT FOR THE SLAVE LAKE AREA, ALBERTA

If a flakeboard plant were built in the Slave Lake area what are its chances of success? This question cannot be answered until an engineering study is undertaken to determine production costs. However, by making a few assumptions we can determine the net mill price and the total mill revenue for any given production.

For this analysis we will assume

1. no export sales

2. no sales in British Columbia
3. 40% of all sales to the rest of Western Canada
4. 60% of all sales to Eastern Canada
5. sales breakdown as follows

	<u>%</u>
a) Calgary	15
b) Edmonton	15
c) Saskatoon-Regina	5
d) Winnipeg	5
e) Toronto	20
f) Ottawa	10
g) Montreal	20
h) Quebec	5
i) Halifax	5
6. that a national distributor will market the product and handle the promotion (This will further reduce the mill net back by 5% to cover the cost of promotion)
7. that net mill prices are calculated for the prices prevailing on August 21, 1970 and September 3, 1971
8. that 1/4" flakeboard is priced 5% below 5/16" flakeboard
9. that 7/16" flakeboard is priced 5% above 3/8" flakeboard

10. that only four thicknesses of flakeboard are produced with production as follows

a)	1/4"	40%
b)	5/16"	20%
c)	3/8"	20%
d)	7/16"	20%

11. that shipments of the above thicknesses are proportionately the same to each market

12. that in year one of operation the selling price to the distributor will be further reduced by 5% for easier market penetration. This will give a total reduction of 15% from the distributor selling price less freight and federal tax

The gross mill revenue for the above product mix may be calculated separately for each destination and thickness by the following formula.

$$\text{GROSS MILL REVENUE} = \sum_{i=1}^{n=4} \sum_{j=1}^{n=9} M_{ij} \times V_{ij}$$

where

M_{ij} = Net mill price for thickness i in market j

V_{ij} = Volume of thickness i sold in market j

i = destination

j = thickness

Table 23 shows the expected first year net mill price for the above four thicknesses, by destination of shipments, for the price that prevailed on August 21, 1970.

Table 23

Expected Net Mill Prices for First Year of Slave Lake
Plant Operation, Based on August 21, 1970 Prices

	$\frac{1}{4}''$ \$/MSF	$\frac{5}{16}''$ \$/MSF	$\frac{3}{8}''$ \$/MSF	$\frac{7}{16}''$ \$/MSF
Calgary	46.62	49.07	51.38	53.95
Edmonton	49.09	51.67	54.47	57.19
Regina	47.36	49.85	52.25	54.86
Saskatoon	48.95	51.53	54.28	56.99
Winnipeg	47.20	49.68	52.01	54.61
Toronto	44.07	46.39	47.84	50.23
Ottawa	44.84	47.20	48.80	51.24
Montreal	44.84	47.20	48.80	51.24
Quebec	44.56	46.91	48.46	50.88
Halifax	45.38	47.77	49.47	51.94

Note: Based On Prices 10% Below Spruce Plywood F.O.B. Destination
Less Freight From Flakeboard Mill To Destination.
Less 5% For Distributor Promotion Cost And 5% Price Reduction
For Market Penetration.

Source: Economic Research Branch

Table 24 reflects the first year net mill price based on September 3, 1971 prices.

Table 24

Expected Net Mill Prices for First Year of Slave Lake
Plant Operation, Based on September 3, 1971 Prices

	<u>1/4"</u> \$/MSF	<u>5/16"</u> \$/MSF	<u>3/8"</u> \$/MSF	<u>7/16"</u> \$/MSF
Calgary	59.04	62.15	67.43	70.80
Edmonton	61.86	65.12	70.91	74.46
Regina	60.83	64.03	69.33	72.80
Saskatoon	62.42	65.71	71.66	75.24
Winnipeg	61.37	64.60	70.26	73.77
Toronto	56.75	59.74	64.39	67.61
Ottawa	57.22	60.23	64.95	68.20
Montreal	57.22	60.23	64.95	68.20
Quebec	57.53	60.56	65.37	68.64
Halifax	57.01	60.01	64.90	68.15

Note: Based On Prices 10% Below Spruce Plywood F.O.B. Destination
Less Freight From Flakeboard Mill To Destination.
Less 5% For Distributor Promotion Cost And 5% Price Reduction
For Market Penetration.

Source: Economic Research Branch

To calculate average net mill price for each thickness and
gross mill revenue based on the above data we will assume that the
plant will produce the following:

1/4"	40 MMSF
5/16"	20 MMSF
3/8"	20 MMSF
7/16"	20 MMSF

Table 25 shows the volumes of each thickness shipped to each market.

Table 25
Volume of Flakeboard, By Thickness Shipped
to Each Destination

	<u>1/4"</u> MMSF	<u>5/16"</u> MMSF	<u>3/8"</u> MMSF	<u>7/16"</u> MMSF
Calgary	6	3	3	3
Edmonton	6	3	3	3
Regina	1	0.5	0.5	0.5
Saskatoon	1	0.5	0.5	0.5
Winnipeg	2	1	1	1
Toronto	8	4	4	4
Ottawa	4	2	2	2
Montreal	8	4	4	4
Quebec	2	1	1	1
Halifax	2	1	1	1
Total	40	20	20	20

Source: Economic Research Branch

Using the above information the following are the average net mill prices by thickness and the gross mill revenue.

TABLE 26

Slave Lake Area Net Mill Prices and Gross Mill Revenue,
By Thickness, Based on August 21, 1970 and September 3, 1971 Prices

August 21, 1970 Prices

<u>Thickness</u> "	<u>Average</u> <u>Net Mill Prices</u> \$	<u>Total</u> <u>Gross Mill Revenue</u> \$
1/4	45.89	1,835,490
5/16	48.30	966,030
3/8	50.25	1,004,915
7/16	52.96	1,059,175
Average and Total	48.66	4,865,610

September 3, 1971 Prices

<u>Thickness</u> "	<u>Average</u> <u>Net Mill Prices</u> \$	<u>Total</u> <u>Gross Mill Revenue</u> \$
1/4	58.53	2,341,110
5/16	61.61	1,232,190
3/8	66.66	1,333,305
7/16	70.00	1,400,000
Average and Total	63.07	6,306,605

Source: Economic Research Branch

MARKET DEMAND

Discussion with major distributors, large wholesale/retail lumber yards and major end users of wood based panel sheathing material, revealed that flakeboard could capture up to 35% of the sheathing market. Currently, flakeboard accounts for only 5% of this market. To increase its share of the market the following conditions must be met:

1. flakeboard priced 10% below the price of Spruce plywood
2. guaranteed supply of sufficient quantity and quality
3. local backup stock

Price

Although flakeboard meets the required specifications for certain sheathing applications it is thought of by the consumer as an "inferior" product. To overcome consumer resistance flakeboard must be priced up to 10% lower than the product which has the next highest consumer acceptance - in this case Spruce plywood. There is reason to believe that once flakeboard is more widely used and available the price differential could be narrowed to 5%.

Supply and Quality

One of the major problems encountered in the marketing of any new product is a constant supply of quality production. End users normally do not like switching from one equivalent product to another. In the short run it is cost increasing even if the product switched to costs less. The reason for this is that there are generally different handling and installation techniques to which tradesmen must become accustomed. Once these techniques are mastered the lower priced product becomes cost reducing.

Many end users claimed they would use flakeboard if they could be guaranteed that they would have access to a constant supply. Presently current users of flakeboard must indicate their requirements up to 90 days in advance of delivery. The demands of new customers cannot be met, especially if they want to place orders of substantial size on a short notice basis.

The quality of the product sold must be high and consistent. All end users stated that the quality must be equal to or greater than similar products now on sale. They were most concerned with this aspect of the product because their customers blamed them and not the manufacturer for defects caused by low quality products.

Local Backup Stock

A local supply of stock is important to end users. Most end users claimed that they usually ordered sufficient quantities of any one product to enable them to complete projects. However unforeseen circumstance often forced them to re-order small quantities of any given product. They claimed that the decision to buy one product over another often hinged on whether or not local stock was available should they run short. Although they had to pay more for one product over another the local supply prevented costly delays and are therefore cheaper in the long run. One end user said, "Its like buying insurance".

CURRENT AND FUTURE MARKET DEMAND

If we assume that the previously mentioned conditions prevail then the market for flakeboard over the past five years would have been as shown in the following table:

<u>Table 27</u>	
Potential Flakeboard Market	
Canada 1966 - 1970	
<u>(MMSF 3/8" Basis)</u>	
	<u>MMSF</u>
1966	336
1967	360
1968	402
1969	403
1970	429

Source: Economic Research Branch

Using the statistics presented under the heading Future Projections and taking those deemed to be most likely the following is the projected potential flakeboard market for Canada. The same assumptions as above are used.

Table 28	
Projected Potential Flakeboard Market	
Canada 1971 - 1975	
(MMSF 3/8" Basis)	
	<u>MMSF</u>
1971	455
1972	490
1973	525
1974	560
1975	595
1976	630

Source: Economic Research Branch

APPENDIX I

Table 1

SHEATHING GRADE(1)
 PLYWOOD USED PER UNIT, RESIDENTIAL CONSTRUCTION,
 BY PROVINCE OR REGION 1969

 (Excluding Apartment Units)

(Sf 3/8" Basis)

	<u>Single Detached Dwellings</u>	<u>Semi- Detached and Duplex Dwellings</u>	<u>Row Housing</u>	<u>Average</u>
Atlantic Provinces	1,191	1,326	1,693	1,228
Quebec	2,084	1,668	1,327	2,002
Ontario	2,886	2,065	1,598	2,614
Prairie Provinces	2,947	2,282	2,044	2,775
British Columbia	3,556	2,882	2,271	3,393
Canada	2,701	2,146	1,755	2,541

(1) Includes all sheathing and decking plus sub-flooring.

Source: Central Mortgage and Housing Corporation.

Table 2

CONSUMPTION OF SHEATHING GRADE PLYWOOD
RESIDENTIAL CONSTRUCTION, BY PROVINCE OR REGION, 1969
 (Excluding Apartments)

(MMSF 3/8" Basis)

	Non-(1) Apartment <u>Dwellings</u>	<u>%</u>	Non- Apartment <u>Dwellings</u>	<u>%</u>
	MMSF		Starts	
Atlantic Provinces	11.9	4.7	9,692	9.7
Quebec	29.4	11.6	14,686	14.8
Ontario	108.2	42.8	41,399	41.6
Sub Total	149.5	59.1	65,777	66.1
Manitoba	12.1	4.8	4,438	4.5
Saskatchewan	9.7	3.9	3,384	3.4
Alberta	28.1	11.1	10,163	10.2
British Columbia	53.4	21.1	15,736	15.8
Total Canada	252.8	100.0	99,498	100.0

(1) Includes Single Detached, Semi-Detached and Duplex, Row Housing

Source: Central Mortgage and Housing Corporation.

Table 3

CONSUMPTION OF SHEATHING GRADE PLYWOOD AND ASPENITE
RESIDENTIAL CONSTRUCTION, BY PROVINCE OR REGION, 1970
(Excluding Apartments)

(MMSF 3/8" Basis)

	Non-(1) Apartment <u>Dwellings</u>	<u>%</u>	Non- Apartment <u>Dwellings</u>	<u>%</u>
	MMSF		Starts	
Atlantic Provinces	16.9	6.0	9,371	9.5
Quebec	52.9	18.8	23,089	22.4
Ontario	96.6	34.4	34,331	34.8
Sub Total	166.4	59.2	65,771	66.7
Manitoba	12.6	4.5	4,892	5.0
Saskatchewan	11.1	3.9	1,627	1.6
Alberta	30.6	10.9	9,894	10.0
British Columbia	60.4	21.5	16,426	16.7
Total	281.1	100.0	98,630	100.0

(1) Includes Single Detached, Semi-Detached and Duplex, Row Housing

Source: Central Mortgage and Housing Corporation.

TABLE 4

FARM BUILDINGS CONSTRUCTION IN CANADA - 1965 AND 1970
(Excluding Dwellings)

	<u>1965</u>		<u>1970</u>	
	\$ Millions	%	\$ Millions	%
Atlantic Provinces	6.6*	3.5	4.5*	2.2
Quebec	36.2	19.0	43.8	21.3
Ontario	61.3	32.2	69.3	33.6
Manitoba	14.1	7.4	13.7	6.7
Saskatchewan	28.4	14.9	24.3	11.8
Alberta	35.7	18.8	45.9	22.3
British Columbia	7.9	4.2	4.4	2.1
Canada	190.2	100.0	205.9	100.0

* Excludes Newfoundland and Prince Edward Island

Source: Dominion Bureau of Statistics, Catalogue No. 64-201.

TABLE 5

DOUGLAS FIR SHEATHING GRADE PLYWOOD PRICES

Destination	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	(1) Trade Discounts \$/MSF		Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Mill Net Back And Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
					Base Price	%/MSF					
					Based on Quoted Prices August 21, 1970						
5/16" Thickness											
Calgary	112.45	5.89	106.56	10.56	96.00	7X5 3	65.03	5 2	60.54	5.89	66.43
Edmonton	114.00	7.13	106.87	10.59	96.28	7X5 3	65.22	5 2	60.72	7.13	67.85
Regina	117.55	9.98	107.57	10.66	96.91	7X5 3	65.65	5 2	61.12	9.98	71.10
Winnipeg	120.90	12.54	108.36	10.74	97.62	7X5 3	66.13	5 2	61.57	12.54	74.11
Toronto	123.25	13.97	109.28	10.83	98.45	7X5 3	66.69	5 2	62.09	13.97	76.06
Ottawa	122.65	14.16	108.49	10.75	97.74	7X5 3	66.21	5 2	61.64	14.16	75.80
Montreal	122.65	14.16	108.49	10.75	97.74	7X5 3	66.21	5 2	61.64	14.16	75.80
Quebec	123.00	14.16	108.84	10.79	98.05	7X5 3	66.42	5 2	61.84	14.16	76.00
Halifax	123.60	15.68	107.92	10.69	97.23	7X5 3	65.86	5 2	61.32	15.68	77.00
Based on Quoted Prices September 3, 1971											
5/16" Thickness											
Calgary	121.75	6.18	115.57	11.45	104.12	3X5 3	86.59	5 2	80.61	6.18	86.79
Edmonton	123.50	7.50	116.00	11.50	104.50	3X5 3	86.91	5 2	80.91	7.50	88.41
Regina	127.40	10.45	116.95	11.59	105.36	3X5 3	87.63	5 2	81.58	10.45	92.03
Winnipeg	131.15	13.21	117.94	11.69	106.25	3X5 3	88.37	5 2	82.27	13.21	95.48
Toronto	132.30	14.06	118.24	11.72	106.52	3X5 3	88.59	5 2	82.48	14.06	96.54
Ottawa	132.30	13.40	118.90	11.78	107.12	3X5 3	89.09	5 2	82.94	13.40	96.34
Montreal	132.30	13.40	118.90	11.78	107.12	3X5 3	89.09	5 2	82.94	13.40	96.34
Quebec	132.55	15.11	117.44	11.64	105.80	3X5 3	87.99	5 2	81.92	15.11	97.03
Halifax	132.80	14.06	118.74	11.77	106.97	3X5 3	88.97	5 2	82.83	14.06	96.89

(1) Madison's Canadian Lumber Reporter.

(2) Department of Highways and Transport, Transport Research and Development Division, 5/16" sheathing weighs 950 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.

(3) Standard discount to distributors.

TABLE 6

DOUGLAS FIR SHEATHING GRADE PLYWOOD PRICES

Destination	(1)	(2)	Price	11%	(1)		Distributor	(3)	Price to		Freight to	Distributor	Price to
	Quoted	Freight	Less	Federal	Base	Trade	Selling	Mill	Discounts	At Vancouver			
	Price	\$/MSF	\$/MSF	Tax	Price	Discounts	Price	Discounts	%/MSF	\$/MSF	\$/MSF	\$/MSF	\$/MSF
Based on Quoted Prices August 21, 1970													
3/8" Thickness													
Calgary	118.40	6.98	111.42	11.04	100.38	7X5 3	68.00	5 2		63.31	6.98		70.29
Edmonton	120.20	8.44	111.76	11.07	100.68	7X5 3	68.20	5 2		63.49	8.44		71.93
Regina	124.45	11.81	112.64	11.16	101.48	7X5 3	68.74	5 2		64.00	11.81		75.81
Winnipeg	128.40	14.85	113.55	11.25	102.30	7X5 3	69.30	5 2		64.52	14.85		78.67
Toronto	130.75	16.54	114.21	11.32	102.89	7X5 3	69.70	5 2		64.89	16.54		81.43
Ottawa	130.05	16.76	113.29	11.23	102.06	7X5 3	69.14	5 2		64.37	16.76		81.13
Montreal	130.05	16.76	113.29	11.23	102.06	7X5 3	69.14	5 2		64.37	16.76		81.13
Quebec	130.45	16.76	113.69	11.27	102.42	7X5 3	69.38	5 2		64.59	16.76		81.35
Halifax	131.15	18.56	112.59	11.16	101.43	7X5 3	68.71	5 2		63.97	18.56		82.53
Based on Quoted Prices September 3, 1971													
3/8" Thickness													
Calgary	133.30	7.31	125.99	12.49	113.50	3X5 3	94.40	5 2		87.89	7.31		95.20
Edmonton	135.40	8.89	126.51	12.54	113.97	3X5 3	94.79	5 2		88.25	8.89		97.14
Regina	140.00	12.49	127.51	12.64	114.87	3X5 3	95.54	5 2		88.95	12.49		101.44
Winnipeg	144.45	15.64	128.81	12.77	116.05	3X5 3	96.52	5 2		89.86	15.64		105.50
Toronto	145.80	16.65	129.15	12.80	116.35	3X5 3	96.77	5 2		90.09	16.65		106.74
Ottawa	145.80	15.86	129.94	12.88	117.06	3X5 3	97.36	5 2		90.64	15.86		106.50
Montreal	145.80	15.86	129.94	12.88	117.06	3X5 3	97.36	5 2		90.64	15.86		106.50
Quebec	146.05	17.89	128.16	12.70	115.46	3X5 3	96.03	5 2		89.40	17.89		107.29
Halifax	146.35	16.65	129.70	12.85	116.85	3X5 3	97.18	5 2		90.47	16.65		107.12

(1) Madison's Canadian Lumber Reporter.

(2) Department of Highways and Transport, Transport Research and Development Division, 3/8" sheathing weighs 1,125 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.

(3) Standard discount to distributors.

TABLE 7

DOUGLAS FIR SHEATHING GRADE PLYWOOD PRICES

<u>Destination</u>	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970											
1/2" Thickness											
Calgary	159.55	9.46	150.09	14.87	135.22	7X5 3	91.60	5 2	85.28	9.46	94.74
Edmonton	162.00	11.44	150.56	14.92	135.64	7X5 3	91.88	5 2	85.54	11.44	96.98
Regina	167.75	16.01	151.74	15.04	136.70	7X5 3	92.60	5 2	86.21	16.01	102.22
Winnipeg	173.10	20.13	152.97	15.16	137.81	7X5 3	93.35	5 2	86.91	20.13	107.04
Toronto	175.50	22.42	153.08	15.17	137.91	7X5 3	93.42	5 2	86.97	22.42	109.39
Ottawa	174.55	22.72	151.83	15.05	136.78	7X5 3	92.65	5 2	86.26	22.72	108.98
Montreal	174.55	22.72	151.83	15.05	136.78	7X5 3	92.65	5 2	86.26	22.72	108.98
Quebec	175.10	22.72	152.38	15.10	137.28	7X5 3	92.99	5 2	86.57	22.72	109.29
Halifax	176.10	25.16	150.94	14.96	135.98	7X5 3	92.11	5 2	85.75	25.16	110.91

Based on Quoted Prices September 3, 1971
1/2" Thickness

Calgary	179.10	9.91	169.19	16.77	152.42	3X5 3	126.77	5 2	118.02	9.91	127.93
Edmonton	181.90	12.05	169.85	16.83	153.02	3X5 3	127.27	5 2	118.95	12.05	131.00
Regina	188.15	16.78	171.37	16.98	154.99	3X5 3	128.91	5 2	120.02	16.78	136.80
Winnipeg	194.15	21.20	172.95	17.14	155.81	3X5 3	129.59	5 2	120.65	21.20	141.85
Toronto	195.95	21.57	173.38	17.18	156.20	3X5 3	129.91	5 2	120.95	22.57	143.52
Ottawa	195.95	21.50	174.45	17.29	157.16	3X5 3	130.71	5 2	121.69	21.50	143.19
Montreal	195.95	21.50	174.45	17.29	157.16	3X5 3	130.71	5 2	121.69	21.50	143.19
Quebec	196.40	24.25	172.15	17.06	155.09	3X5 3	128.99	5 2	120.09	24.25	144.34
Halifax	196.80	22.57	174.23	17.27	156.96	3X5 3	130.54	5 2	121.53	22.57	144.10

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 1/2" sheathing weighs 1,525 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 8

DOUGLAS FIR SHEATHING GRADE PLYWOOD PRICES

Destination	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970 5/8" Thickness											
Calgary	188.70	11.32	177.38	17.58	159.80	7X5 3	108.25	5 2	100.78	11.32	112.10
Edmonton	191.70	13.69	178.01	17.64	160.37	7X5 3	108.63	5 2	101.13	13.69	114.82
Regina	198.55	19.16	179.39	17.78	161.61	7X5 3	109.47	5 2	101.92	19.16	121.08
Winnipeg	204.95	24.09	180.86	17.92	162.94	7X5 3	110.38	5 2	102.76	24.09	126.85
Toronto	208.50	26.83	181.67	18.00	163.67	7X5 3	110.87	5 2	103.22	26.83	130.05
Ottawa	207.35	27.19	180.16	17.85	162.31	7X5 3	109.95	5 2	102.36	27.19	129.55
Montreal	207.35	27.19	180.16	17.85	162.31	7X5 3	109.95	5 2	102.36	27.19	129.55
Quebec	208.05	27.19	180.86	17.92	162.94	7X5 3	110.38	5 2	102.76	27.19	129.95
Halifax	209.20	30.11	179.09	17.75	161.34	7X5 3	109.29	5 2	101.75	30.11	131.86

Based on Quoted Prices September 3, 1971
5/8" Thickness

Calgary	210.65	11.86	198.79	19.70	179.09	3X5 3	148.95	5 2	138.67	11.86	150.53
Edmonton	214.00	14.42	199.58	19.78	179.80	3X5 3	149.54	5 2	139.22	14.42	153.64
Regina	221.45	20.08	201.37	19.96	181.41	3X5 3	150.88	5 2	140.47	20.08	160.55
Winnipeg	228.70	25.37	203.33	20.15	183.18	3X5 3	152.35	5 2	141.84	25.37	167.21
Toronto	230.85	27.01	203.84	20.20	183.64	3X5 3	152.73	5 2	142.19	27.01	169.20
Ottawa	230.85	25.73	205.12	20.33	184.79	3X5 3	153.69	5 2	143.09	25.73	168.82
Montreal	230.85	25.73	205.12	20.33	184.79	3X5 3	153.69	5 2	143.09	25.73	168.82
Quebec	231.35	29.02	202.33	20.05	182.28	3X5 3	151.60	5 2	141.14	29.02	170.16
Halifax	231.80	27.01	204.79	20.29	184.50	3X5 3	153.45	5 2	142.86	27.01	169.87

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 5/8" sheathing weighs 1,825 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 9

DOUGLAS FIR SHEATHING GRADE PLYWOOD PRICES

<u>Destination</u>	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970											
3/4" Thickness											
Calgary	227.65	13.80	213.85	21.19	192.66	7X5 3	130.51	5 2	121.50	13.80	135.30
Edmonton	231.25	16.69	214.56	21.26	193.30	7X5 3	130.94	5 2	121.91	16.69	138.60
Regina	239.55	23.36	216.19	21.42	194.77	7X5 3	131.94	5 2	122.84	23.36	146.20
Winnipeg	247.45	29.37	218.08	21.61	196.47	7X5 3	133.09	5 2	123.91	29.37	153.28
Toronto	252.15	32.71	219.44	21.75	197.69	7X5 3	133.92	5 2	124.68	32.71	157.39
Ottawa	250.75	33.15	217.60	21.56	196.04	7X5 3	132.80	5 2	123.64	33.15	156.79
Montreal	250.75	33.15	217.60	21.56	196.04	7X5 3	132.80	5 2	123.64	33.15	156.79
Quebec	251.60	33.15	218.45	21.65	196.80	7X5 3	133.31	5 2	124.11	33.15	157.26
Halifax	253.00	36.71	216.29	21.43	194.86	7X5 3	132.00	5 2	122.89	36.71	159.60

Based on Quoted Prices September 3, 1971
3/4" Thickness

Calgary	258.60	14.46	244.14	24.19	219.95	3X5 3	182.93	5 2	170.31	14.46	184.77
Edmonton	262.75	17.58	245.17	24.30	220.87	3X5 3	183.70	5 2	171.02	17.58	188.60
Regina	271.80	24.48	247.32	24.51	222.81	3X5 3	185.31	5 2	172.52	24.48	197.00
Winnipeg	280.60	30.93	249.67	24.74	224.93	3X5 3	187.07	5 2	174.16	30.93	205.09
Toronto	283.25	32.93	251.88	24.81	225.51	3X5 3	187.56	5 2	174.62	32.93	207.55
Ottawa	283.25	31.37	251.88	24.96	226.92	3X5 3	188.73	5 2	175.71	31.37	207.08
Montreal	283.25	31.37	251.88	24.96	226.92	3X5 3	188.73	5 2	175.71	31.37	207.08
Quebec	283.85	35.38	248.47	24.62	226.59	3X5 3	186.18	5 2	173.33	35.38	208.71
Halifax	284.45	32.93	251.52	24.93	251.52	3X5 3	188.45	5 2	175.45	32.93	208.38

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 3/4" sheathing weighs 1,225 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 10

SPRUCE SHEATHING GRADE PLYWOOD PRICES

Destination	(1) Quoted Price	(2) Freight	Price Less Freight	11% Federal Tax	Base Price	(1) Trade Discounts	Distributor Selling Price	(3) Mill Discounts	Price to Distributor At Vancouver	Freight to Destination	Price to Distributor F.O.B. Destination
	\$/MSF	\$/MSF	\$/MSF	\$/MSF	\$/MSF	%/MSF	\$/MSF	%/MSF	\$/MSF	\$/MSF	\$/MSF
Based on Quoted Prices August 21, 1970											
5/16" Thickness											
Calgary					89.00	6X5 3	63.46	5 2	59.08	5.89	64.97
Edmonton					89.00	6X5 3	63.46	5 2	59.08	7.13	66.21
Regina					89.00	6X5 3	63.46	5 2	59.08	9.98	69.06
Winnipeg					89.00	6X5 3	63.46	5 2	59.08	12.54	71.62
Toronto					91.00	6X5 3	64.88	5 2	60.40	13.97	74.37
Ottawa					91.00	6X5 3	64.88	5 2	60.40	14.16	74.56
Montreal					91.00	6X5 3	64.88	5 2	60.40	14.16	74.56
Quebec					91.00	6X5 3	64.88	5 2	60.40	14.16	74.56
Halifax					91.00	6X5 3	64.88	5 2	60.40	15.68	76.08

Based on Quoted Prices September 3, 1971
5/16" Thickness

Calgary	119.25	6.18	113.07	11.21	101.86	4X5 3	80.48	5 2	74.93	6.18	81.11
Edmonton	121.15	7.50	113.65	11.26	102.39	4X5 3	80.90	5 2	75.32	7.50	82.82
Regina	125.30	10.45	114.85	11.38	103.47	4X5 3	81.75	5 2	76.11	10.45	86.56
Winnipeg	129.15	13.21	115.94	11.49	104.45	4X5 3	82.53	5 2	76.84	13.21	90.05
Toronto	129.95	14.06	115.89	11.48	104.41	4X5 3	82.49	5 2	76.80	14.06	90.86
Ottawa	129.95	13.40	116.55	11.55	105.00	4X5 3	82.96	5 2	77.24	13.40	90.64
Montreal	129.95	13.40	116.55	11.55	105.00	4X5 3	82.96	5 2	77.24	13.40	90.64
Quebec	130.25	15.11	115.14	11.41	103.73	4X5 3	81.96	5 2	76.30	15.11	91.41
Halifax	130.45	14.06	116.39	11.53	104.86	4X5 3	82.85	5 2	77.13	14.06	91.19

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 5/16" sheathing weighs 950 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 11

SPRUCE SHEATHING GRADE PLYWOOD PRICES

Destination	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Whl Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970											
3/8" Thickness											
Calgary					93.00	6X5 3	66.31	5 2	61.73	6.98	68.71
Edmonton					93.00	6X5 3	66.31	5 2	61.73	8.44	70.17
Regina					93.00	6X5 3	66.31	5 2	61.73	11.81	73.54
Winnipeg					93.00	6X5 3	66.31	5 2	61.73	14.85	76.58
Toronto					95.00	6X5 3	67.74	5 2	63.07	16.54	79.61
Ottawa					95.00	6X5 3	67.74	5 2	63.07	16.76	79.83
Montreal					95.00	6X5 3	67.74	5 2	63.07	16.76	79.83
Quebec					95.00	6X5 3	67.74	5 2	63.07	16.76	79.83
Halifax					95.00	6X5 3	67.74	5 2	63.07	18.56	81.63

Based on Quoted Prices September 3, 1971
3/8" Thickness

Calgary	129.85	7.31	122.54	12.14	110.40	4X5 3	87.23	5 2	81.21	7.31	88.52
Edmonton	132.00	8.89	123.11	12.20	110.91	4X5 3	87.63	5 2	81.58	8.89	90.47
Regina	137.00	12.49	124.51	12.34	112.17	4X5 3	88.63	5 2	82.51	12.49	95.00
Winnipeg	141.60	15.64	125.96	12.48	113.48	4X5 3	89.66	5 2	83.47	15.64	99.11
Toronto	142.50	16.65	125.85	12.47	113.38	4X5 3	89.58	5 2	83.40	16.65	100.05
Ottawa	142.50	15.86	126.64	12.55	114.09	4X5 3	90.14	5 2	83.92	15.86	99.78
Montreal	142.50	15.86	126.64	12.55	114.09	4X5 3	90.14	5 2	83.92	15.86	99.78
Quebec	142.85	17.89	124.96	12.38	112.58	4X5 3	88.95	5 2	82.81	17.89	100.70
Halifax	143.45	16.65	126.80	12.57	114.23	4X5 3	90.25	5 2	84.02	16.65	100.67

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 3/8" sheathing weighs 1,125 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 12

SPRUCE SHEATHING GRADE PLYWOOD PRICES

<u>Destination</u>	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970 1/2" Thickness											
Calgary					125.00	6X5 3	89.13	5 2	82.98	9.46	92.44
Edmonton					125.00	6X5 3	89.13	5 2	82.98	11.44	94.42
Regina					125.00	6X5 3	89.13	5 2	82.98	16.01	98.99
Winnipeg					125.00	6X5 3	89.13	5 2	82.98	20.13	103.11
Toronto					127.00	6X5 3	90.55	5 2	84.30	22.42	106.72
Ottawa					127.00	6X5 3	90.55	5 2	84.30	22.72	107.02
Montreal					127.00	6X5 3	90.55	5 2	84.30	22.72	107.02
Quebec					127.00	6X5 3	90.55	5 2	84.30	22.72	107.02
Halifax					127.00	6X5 3	90.55	5 2	84.30	25.16	109.46

Based on Quoted Prices September 3, 1971
1/2" Thickness

Calgary	174.90	9.91	164.99	16.35	148.64	4X5 3	117.44	5 2	109.34	9.91	119.25
Edmonton	177.85	12.05	165.80	16.43	149.37	4X5 3	118.02	5 2	109.88	12.05	121.93
Regina	184.65	16.78	167.87	16.64	151.23	4X5 3	119.49	5 2	111.25	16.78	128.03
Winnipeg	190.75	21.20	169.55	16.80	152.75	4X5 3	120.69	5 2	112.36	21.20	133.56
Toronto	192.05	22.57	169.48	16.80	152.68	4X5 3	120.63	5 2	112.31	22.57	134.88
Ottawa	192.05	21.50	170.55	16.90	153.65	4X5 3	121.40	5 2	113.02	21.50	134.52
Montreal	192.05	21.50	170.55	16.90	153.65	4X5 3	121.40	5 2	113.02	21.50	134.52
Quebec	192.45	24.25	168.20	16.67	151.53	4X5 3	119.72	5 2	111.46	24.25	135.71
Halifax	193.30	22.57	170.73	16.92	153.81	4X5 3	121.52	5 2	113.14	22.57	135.71

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 1/2" sheathing weighs 1,525 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

TABLE 13

SPRUCE SHEATHING GRADE PLYWOOD PRICES

<u>Destination</u>	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	1% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970											
5/8" Thickness											
Calgary					148.00	6X5 3	105.52	5 2	98.24	11.32	109.56
Edmonton					148.00	6X5 3	105.52	5 2	98.24	13.69	111.93
Regina					148.00	6X5 3	105.52	5 2	98.24	19.16	117.40
Winnipeg					148.00	6X5 3	105.52	5 2	98.24	24.09	122.33
Toronto					151.00	6X5 3	107.66	5 2	100.23	26.83	127.06
Ottawa					151.00	6X5 3	107.66	5 2	100.23	27.19	127.42
Montreal					151.00	6X5 3	107.66	5 2	100.23	27.19	127.42
Quebec					151.00	6X5 3	107.66	5 2	100.23	27.19	127.42
Halifax					151.00	6X5 3	107.66	5 2	100.23	30.11	130.34

Based on Quoted Prices September 3, 1971
5/8" Thickness

Calgary	204.50	11.86	192.64	19.09	173.55	4X5 3	137.12	5 2	127.66	11.86	139.52
Edmonton	208.00	14.42	193.58	19.18	174.40	4X5 3	137.79	5 2	128.28	14.42	142.70
Regina	216.15	20.08	196.07	19.43	176.64	4X5 3	139.56	5 2	129.93	20.08	150.01
Winnipeg	223.50	25.37	198.13	19.63	178.50	4X5 3	141.03	5 2	131.30	25.37	156.67
Toronto	225.00	25.01	197.99	19.62	178.37	4X5 3	140.93	5 2	131.21	27.01	158.22
Ottawa	225.00	25.73	199.27	19.75	179.52	4X5 3	141.84	5 2	132.05	25.73	157.78
Montreal	225.00	25.73	199.27	19.75	179.52	4X5 3	141.84	5 2	132.05	25.73	157.78
Quebec	225.50	29.02	196.48	19.47	177.01	4X5 3	139.86	5 2	130.21	29.02	159.23
Halifax	226.55	27.01	199.54	19.77	179.77	4X5 3	142.04	5 2	132.24	27.01	159.25

- (1) Madison's Canadian Lumber Reporter.
- (2) Department of Highways and Transport, Transport Research and Development Division, 5/8" sheathing weighs 1,825 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
- (3) Standard discount to distributors.

TABLE 14

SPRUCE SHEATHING GRADE PLYWOOD PRICES

<u>Destination</u>	(1) Quoted Price \$/MSF	(2) Freight \$/MSF	Price Less Freight \$/MSF	11% Federal Tax \$/MSF	Base Price \$/MSF	(1) Trade Discounts %/MSF	Distributor Selling Price \$/MSF	(3) Mill Discounts %/MSF	Price to Distributor At Vancouver \$/MSF	Freight to Destination \$/MSF	Price to Distributor F.O.B. Destination \$/MSF
Based on Quoted Prices August 21, 1970											
3/4" Thickness											
Calgary					178.00	6X5 3	126.91	5 2	118.15	13.80	131.95
Edmonton					178.00	6X5 3	126.91	5 2	118.15	16.69	134.84
Regina					178.00	6X5 3	126.91	5 2	118.15	23.36	141.51
Winnipeg					178.00	6X5 3	126.91	5 2	118.15	29.37	147.52
Toronto					182.00	6X5 3	129.77	5 2	120.82	32.71	153.53
Ottawa					182.00	6X5 3	129.77	5 2	120.82	33.15	153.97
Montreal					182.00	6X5 3	129.77	5 2	120.82	33.15	153.97
Quebec					182.00	6X5 3	129.77	5 2	120.82	33.15	153.97
Halifax					182.00	6X5 3	129.77	5 2	120.82	36.71	157.53

Based on Quoted Prices September 3, 1971
3/4" Thickness

Calgary	250.60	14.46	236.14	23.40	212.74	4X5 3	168.09	5 2	156.49	14.46	170.95
Edmonton	254.90	17.58	237.32	23.52	213.80	4X5 3	168.92	5 2	157.26	17.58	174.84
Regina	264.80	24.48	240.32	23.82	210.50	4X5 3	171.06	5 2	159.26	24.48	183.74
Winnipeg	273.75	30.93	242.82	24.06	218.76	4X5 3	172.84	5 2	160.91	30.93	191.84
Toronto	275.55	32.93	242.62	24.04	218.58	4X5 3	172.70	5 2	160.78	32.93	193.71
Ottawa	275.55	31.37	244.18	24.20	219.98	4X5 3	173.81	5 2	161.82	31.37	193.19
Montreal	275.55	31.37	244.18	24.20	219.98	4X5 3	173.81	5 2	161.82	31.37	193.19
Quebec	276.20	35.38	240.82	23.87	216.96	4X5 3	171.42	5 2	159.59	35.38	194.97
Halifax	277.45	32.93	244.52	24.23	220.29	4X5 3	174.05	5 2	162.04	32.93	194.97

- (1) Madison's Canadian Lumber Reporter.
 (2) Department of Highways and Transport, Transport Research and Development Division, 3/4" sheathing weighs 2,225 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed.
 (3) Standard discount to distributors.

Table 15

SHEATHING GRADE FLAKEBOARD
(Federal Tax Not Included)

<u>Destination</u>	Price (1) of Spruce to Distributor F.O.B.		Price of Flakeboard to Distributor F.O.B.		(3) Freight to Destination From Slave Lake Area Alberta	Net Mill Price at Slave Lake Alberta
	<u>Destination</u>	(2) 10%	<u>Destination</u>			
	\$/MSF	\$/MSF	\$/MSF	\$/MSF	\$/MSF	\$/MSF
Estimated Prices August 21, 1970 5/16" Thickness						
Calgary	64.97	6.50	58.47	3.95	54.52	
Edmonton	66.21	6.62	59.59	2.18	57.41	
Regina	69.06	6.91	62.15	6.76	55.39	
Saskatoon	69.06	6.91	62.15	4.89	57.26	
Winnipeg	71.62	7.16	64.46	9.26	55.20	
Toronto	74.37	7.44	66.93	15.39	51.54	
Ottawa	74.56	7.46	67.10	14.66	52.44	
Montreal	74.56	7.46	67.10	14.66	52.44	
Quebec	74.56	7.46	67.10	14.98	52.12	
Halifax	76.08	7.61	68.47	15.39	53.08	

Estimated Prices September 1, 1971
5/16" Thickness

Calgary	81.11	8.11	73.00	3.95	69.05
Edmonton	82.82	8.28	74.54	2.18	72.36
Regina	86.56	8.66	77.90	6.76	71.14
Saskatoon	86.56	8.66	77.90	4.89	73.01
Winnipeg	90.05	9.01	81.04	9.26	71.78
Toronto	90.86	9.09	81.77	15.39	66.38
Ottawa	90.64	9.06	81.58	14.66	66.92
Montreal	90.64	9.06	81.58	14.66	66.92
Quebec	91.41	9.14	82.27	14.98	67.29
Halifax	91.19	9.12	82.07	15.39	66.68

(1) See Table 10

(2) Price of Flakeboard for destination assumed to be 10% lower than the price of Spruce.

(3) Department of Industry and Commerce, Transport Research and Development Division, 5/16" Flakeboard weighs 1,040 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed. Freight rates for Flakeboard out of Slave Lake Area not available, therefore lumber rates were used. Rates prior to May 20, 1971 not available, therefore May 20, 1971 rates were used.

Table 16

SHEATHING GRADE FLAKEBOARD
(Federal Tax Not Included)

	Price (1) of Spruce to Distributor F.O.B.	(2)	Price of Flakeboard to Distributor F.O.B.	(3) Freight to Destination From Slave Lake Area Alberta	Net Mill Price at Slave Lake Alberta
<u>Destination</u>	<u>Destination</u>	<u>10%</u>	<u>Destination</u>	<u>Alberta</u>	<u>Alberta</u>
	\$/MSF	\$/MSF	\$/MSF	\$/MSF	\$/MSF
Estimated Prices August 21, 1970					
3/8" Thickness					
Calgary	68.71	6.87	61.84	4.75	57.09
Edmonton	70.17	7.02	63.15	2.63	60.52
Regina	73.54	7.35	66.19	8.13	58.06
Saskatoon	73.54	7.35	66.19	5.88	60.31
Winnipeg	76.58	7.66	68.92	11.13	57.79
Toronto	79.61	7.96	71.65	18.50	53.15
Ottawa	79.83	7.98	71.85	17.63	54.22
Montreal	79.83	7.98	71.85	17.63	54.22
Quebec	79.83	7.98	71.85	18.00	53.85
Halifax	81.63	8.16	73.47	18.50	54.97

Estimated Prices September 1, 1971
3/8" Thickness

Calgary	88.52	8.85	79.67	4.75	74.92
Edmonton	90.47	9.05	81.42	2.63	78.79
Regina	95.00	9.50	85.50	8.13	77.37
Saskatoon	95.00	9.50	85.50	5.88	79.62
Winnipeg	99.11	9.91	89.20	11.13	78.07
Toronto	100.05	10.01	90.04	18.50	71.54
Ottawa	99.78	9.98	89.80	17.63	72.17
Montreal	99.78	9.98	89.80	17.63	72.17
Quebec	100.70	10.07	90.63	18.00	72.63
Halifax	100.67	10.07	90.61	18.50	72.11

(1) See Table 11

(2) Price of Flakeboard for destination assumed to be 10% lower than the price of Spruce.

(3) Department of Industry and Commerce, Transport Research and Development Division, 3/8" Flakeboard weighs 1,250 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed. Freight rates for Flakeboard out of Slave Lake Area not available, therefore lumber rates were used. Rates prior to May 20, 1971 not available, therefore May 20, 1971 rates were used.

Table 17

SHEATHING GRADE FLAKEBOARD
(Federal Tax Not Included)

<u>Destination</u>	Price (1) of Spruce to Distributor F.O.B.	(2)	Price of Flakeboard to Distributor F.O.B.	(3) Freight to Destination From Slave Lake Area Alberta	Net Mill Price at Slave Lake Alberta
	<u>Destination</u>	<u>10%</u>	<u>Destination</u>	<u>Alberta</u>	<u>Alberta</u>
	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>
Estimated Prices August 21, 1970 1/2" Thickness					
Calgary	92.44	9.24	83.20	6.35	76.85
Edmonton	94.42	9.44	84.98	3.51	81.47
Regina	98.99	9.90	89.09	10.86	78.23
Saskatoon	98.99	9.90	89.09	7.85	81.24
Winnipeg	103.11	10.31	92.80	14.86	77.94
Toronto	106.72	10.67	96.05	24.72	71.33
Ottawa	107.02	10.70	96.32	23.55	72.77
Montreal	107.02	10.70	96.32	23.55	72.77
Quebec	107.02	10.70	96.32	24.05	72.27
Halifax	109.46	10.95	98.51	24.72	73.79

Estimated Prices September 1, 1971
1/2" Thickness

Calgary	119.25	11.93	107.32	6.35	100.97
Edmonton	121.93	12.19	109.74	3.51	106.23
Regina	128.03	12.80	115.23	10.86	104.37
Saskatoon	128.03	12.80	115.23	7.85	107.38
Winnipeg	133.56	13.36	120.20	14.86	105.34
Toronto	134.88	13.49	121.39	24.72	96.67
Ottawa	134.52	13.45	121.07	23.55	97.52
Montreal	134.52	13.45	121.07	23.55	97.52
Quebec	135.71	13.57	122.14	24.05	98.09
Halifax	135.71	13.57	122.14	24.72	97.42

(1) See Table 12

(2) Price of Flakeboard for destination assumed to be 10% lower than the price of Spruce.

(3) Department of Industry and Commerce, Transport Research and Development Division, 1/2" Flakeboard weighs 1,670 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed. Freight rates for Flakeboard out of Slave Lake Area not available, therefore lumber rates were used. Rates prior to May 20, 1971 not available, therefore May 20, 1971 rates were used.

Table 18

SHEATHING GRADE FLAKEBOARD
(Federal Tax Not Included)

<u>Destination</u>	Price (1) of Spruce to Distributor F.O.B.	(2)	Price of Flakeboard to Distributor F.O.B.	(3) Freight to Destination From Slave Lake Area Alberta	Net Mill Price at Slave Lake Alberta
	<u>Destination</u>	10%	<u>Destination</u>	<u>Alberta</u>	<u>Alberta</u>
	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>
Estimated Prices August 21, 1970 5/8" Thickness					
Calgary	109.56	10.96	98.60	7.90	90.70
Edmonton	111.93	11.19	100.74	4.37	96.37
Regina	117.40	11.74	105.66	13.52	92.14
Saskatoon	117.40	11.74	105.66	9.78	95.88
Winnipeg	122.33	12.23	110.10	18.51	91.59
Toronto	127.06	12.71	114.35	30.78	83.57
Ottawa	127.42	12.74	114.68	29.33	85.35
Montreal	127.42	12.74	114.68	29.33	85.35
Quebec	127.42	12.74	114.68	29.95	84.73
Halifax	130.34	13.03	117.31	30.78	86.53

Estimated Prices September 1, 1971 5/8" Thickness					
Calgary	139.52	13.95	125.57	7.90	117.67
Edmonton	142.70	14.27	128.43	4.37	124.06
Regina	150.01	15.00	135.01	13.52	121.49
Saskatoon	150.01	15.00	135.01	9.78	125.23
Winnipeg	156.67	15.67	141.00	18.51	122.49
Toronto	158.22	15.82	142.40	30.78	111.62
Ottawa	157.78	15.78	142.40	29.33	112.67
Montreal	157.78	15.78	142.40	29.33	112.67
Quebec	159.23	15.92	143.31	29.95	113.36
Halifax	159.25	15.93	143.32	30.78	112.54

(1) See Table 13

(2) Price of Flakeboard for destination assumed to be 10% lower than the price of Spruce.

(3) Department of Industry and Commerce, Transport Research and Development Division, 5/8" Flakeboard weighs 2,080 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed. Freight rates for Flakeboard out of Slave Lake Area not available, therefore lumber rates were used. Rates prior to May 20, 1971 not available, therefore May 20, 1971 rates were used.

Table 19

SHEATHING GRADE FLAKEBOARD
(Federal Tax Not Included)

<u>Destination</u>	Price (1) of Spruce to Distributor F.O.B.	(2) 10%	Price of Flakeboard to Distributor F.O.B.	(3) Freight to Destination From Slave Lake Area Alberta	Net Mill Price at Slave Lake Alberta
	<u>Destination</u>	<u>10%</u>	<u>Destination</u>	<u>Alberta</u>	<u>Alberta</u>
	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>	<u>\$/MSF</u>
Estimated Prices August 21, 1970 3/4" Thickness					
Calgary	131.95	13.20	118.75	9.50	109.25
Edmonton	134.84	13.48	121.36	5.25	116.11
Regina	141.51	14.15	127.36	16.25	111.11
Saskatoon	141.51	14.15	127.36	11.75	115.61
Winnipeg	147.52	14.75	132.77	22.25	110.52
Toronto	153.53	15.35	138.18	37.00	101.18
Ottawa	153.97	15.40	138.57	35.25	103.32
Montreal	153.97	15.40	138.57	35.25	103.32
Quebec	153.97	15.40	138.57	36.00	102.57
Halifax	157.53	15.75	141.78	37.00	104.78

Estimated Prices September 1, 1971
3/4" Thickness

Calgary	170.95	17.10	153.85	9.50	144.35
Edmonton	174.84	17.48	157.36	5.25	152.11
Regina	183.74	18.37	165.37	16.25	149.12
Saskatoon	183.74	18.37	165.37	11.75	153.62
Winnipeg	191.84	19.18	172.66	22.25	150.41
Toronto	193.71	19.37	174.34	37.00	137.34
Ottawa	193.19	19.32	173.87	35.25	138.62
Montreal	193.19	19.32	173.87	35.25	138.62
Quebec	194.97	19.50	175.47	36.00	139.47
Halifax	194.97	19.50	175.47	37.00	138.47

(1) See Table 14

(2) Price of Flakeboard for destination assumed to be 10% lower than the price of Spruce.

(3) Department of Industry and Commerce, Transport Research and Development Division, 3/4" Flakeboard weighs 2,500 pounds per 1,000 square feet, 80,000 pound minimum shipment assumed. Freight rates for Flakeboard out of Slave Lake Area not available, therefore lumber rates were used. Rates prior to May 20, 1971 not available, therefore May 20, 1971 rates were used.

A P P E N D I X I I

CSA STANDARD 0188-1968

MAT-FORMED WOOD PARTICLEBOARD



PUBLISHED, DECEMBER, 1968
BY THE
CANADIAN STANDARDS ASSOCIATION
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OTTAWA 3, CANADA

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O188-1968

MAT-FORMED WOOD PARTICLEBOARD

1. SCOPE

1.1 This Standard applies to mat-formed wood particleboard; it specifies the requirements for various physical and mechanical properties and includes the test methods to be used for measuring these properties.

PREFACE

CSA Standard O188, Mat-Formed Wood Particleboard is the first Standard of its kind published by Canadian Standards Association.

This Standard, which specifies the requirements for various physical and mechanical properties and the test methods for evaluating these properties, provides a national standard of quality for mat-formed wood particleboard presently manufactured in Canada in accordance with the principal demands of the trade.

In preparing this Standard reference has been made to, and certain information used from, ASTM Standard D1037-61, Methods of Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials.

This Standard was prepared by the CSA Committee on Particle Boards under the jurisdiction of the Sectional Committee on Timber, and was formally approved by these Committees and the CSA Technical Council.

(OTTAWA, DECEMBER, 1968)

NOTE: In order to keep abreast of progress in the industries concerned, CSA publications are subject to periodic revision. Suggestions for improvement will be welcomed at all times. They will be recorded and, in due course brought to the attention of the appropriate committee for consideration.

Also, requests for interpretation or amendment will be accepted by the Committee. They should be worded in such a manner as to permit a simple "yes" or "no" answer based on the literal text of this document concerned.

All enquiries regarding this Standard should be addressed to the General Manager, Administration Division, Canadian Standards Association, 77 Spencer Street, Ottawa 3.

REFERENCE PUBLICATION

This publication makes reference to the following and the year dates shown indicate the latest issues available at the time of printing:

ASTM* Standard D1037-61 — Methods of Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials.

*American Society for Testing and Materials.

2. CLASSIFICATION

2.1 General. Particleboards are classified as to end use category, type, and grade in accordance with Table 1. Property requirements for particleboards are shown in Tables 2 and 3.

TABLE 1
CLASSIFICATION OF PARTICLEBOARDS

End Use Category	Type	Grades
*Industrial Board	II	R, S, T
†Building Board	I II	P E, F, G, H

*Sold for use in remanufacture into items such as tabletops, countertops, and cabinets.

†Sold down to the retail level for use in building applications such as sheathing, floor underlayment, and cladding.

2.2 Board Types. Two types of board are distinguished in this Standard as follows:

(a) **Type I** — made with a highly waterproof resin binder (usually phenol-formaldehyde) suitable for applications of a structural nature and also for many applications in which the panels are exposed directly to the weather. Type I boards may also be used for any application provided they meet all of the pertinent test requirements of this Standard for the Grade; and

(b) **Type II** — made with a water-resistant adhesive (usually urea-formaldehyde) for applications in which the special properties of Type I board are not required.

2.3 Grades. Various sub-categories of wood particleboard are designated in this Standard by a Grade. These grades correspond to various end uses based on present-day practice. Any particular product in this Standard may be completely described by the letter of the grade.

NOTES: 1. Appendix A provides a list of recommended end uses for the various grades of particleboard. These end uses are those in which the particular grade of particleboard has generally been found to be satisfactory when used in a skilled manner.

2. Particleboard is manufactured in various panel sizes. It can also be supplied by various manufacturers in cut-to-size. Particleboard is ordinarily made in various thicknesses ranging from about 3/8 inch to about 1 1/4 inch. For a complete purchase specification, it is necessary to specify both the panel dimensions and the thickness in addition to the grade, and also whether the panel is to be sanded on one or both faces.

3. DEFINITIONS

3.1 The following definitions apply in this Standard:

Additive means any material included in wood particleboard other than the primary components which are wood and adhesive binder;

Binder means a thermosetting bonding agent, which bonds the wood particles together to produce particleboard;

Chip means a small piece of wood chopped off a block by axe-like cuts as in a chipper of the paper industry, or produced by mechanical hogs, hammermills, etc.;

Chipboard is a common term used in England instead of the term particleboard. The term chipboard also has been used to some extent in North America. For the purpose of this Standard the term "Particleboard" has been adopted as the generic term for this type of product regardless of the type of wood particle which is used to make the board;

Flake means a small wood particle of predetermined dimensions specifically produced by specialized equipment of various types, with the cutting action along the direction of the grain (either radially, tangentially, or at an angle between), so as to produce a particle of uniform thickness, essentially flat, having the fibre direction essentially in the plane of the flakes, and resembling a small piece of very thin veneer in overall character;

Flakeboard is a term applied to particleboard made wholly from wood flakes, as distinguished from other particleboards which are made from various forms of wood residue such as planer shavings;

Graduated means a type of construction in which a mixture of wood particles of various sizes are simultaneously formed into a mat in such a way that the coarsest particles form in the centre of the board and the finest particles form on the outside faces of the board. In this construction, the particle size varies gradually from the centre to the face of the board thickness;

Homogeneous means a type of construction in which there is no intentional segregation of particle sizes throughout the thickness of the particleboard;

Mat-formed particleboard means a particleboard in which, because of the method of mat formation, the direction of the grain in the wood particles lies predominantly in the plane of the board. In extruded particleboard (to which this Standard does not apply) the direction of the grain of the wood particles lies predominantly in a direction perpendicular to the plane of the board;

Multilayer means a type of construction in which the wood particles are made or classified into different sizes and formed separately so as to produce a mat in which the thinner particles are applied to the outside faces and the thicker particles are applied as a separate layer to form the centre layer (core) of the board. Three-layer constructions are most common;

Particleboard means a panel material composed of small discrete pieces of wood which, after the application of an adhesive binder, are compacted by heat and pressure to cure the adhesive and form a rigid panel;

Shaving means a small wood particle of indefinite dimensions developed incidental to certain woodworking operations involving rotary cuttersheds turning in the direction of the grain; because of this cutting action, a thin

curled particle of varying thickness is obtained, usually feathered along at least one edge and thick at another edge;

Sliver means small wood particle of nearly square or rectangular cross-section with a length parallel to the grain of the wood at least four times the thickness.

4. GENERAL REQUIREMENTS

4.1 **Construction.** The particleboard covered by this Standard shall be formed as a flat-pressed panel consisting of particles of wood bonded together with a thermosetting adhesive by means of controlled production methods. The panels may be of a homogeneous, multilayered, or graduated construction. The methods and controls used shall be such as to produce particleboard panels which are continuously in accord with all of the requirements of this Standard for the grade of board being produced, within the tolerances limits defined by Clause 5.1.3.

Note: In general, the production methods include classifying the particles by size and drying them to a uniform moisture content, after which they are mixed with a binder, and formed into a panel, compressed to the desired density, and then cured under heat and pressure.

4.2 Materials

4.2.1 **Wood.** The wood particles shall be flakes, chips, shavings, slivers, or other particle forms that are produced from natural wood by cutting, hammermilling, grinding, or similar processes.

4.2.2 **Binder.** The adhesives used for binding together the wood particles shall be the following:

- (a) **Type I** — For Type I particleboard the adhesive binder shall consist of a phenol-formaldehyde resin or any thermosetting adhesive which is not inferior to phenol-formaldehyde resin in moisture resistance, heat resistance, and resistance to attack by fungi and micro-organisms; and
- (b) **Type II** — For Type II particleboard, the adhesive binder shall consist of urea-formaldehyde resin or any thermosetting adhesive which is not inferior to a urea-formaldehyde resin in moisture resistance, heat resistance, and resistance to attack by fungi and micro-organisms.

4.2.3 **Additives.** Suitable materials may be added to the particleboard for the purpose of improving the resistance of the board to such things as fire, penetration of moisture, or attack by micro-organisms or insects, provided that the particleboard containing the additives meets all the applicable requirements of this Standard.

4.3 **Sanding.** Particleboard may be provided either sanded or unsanded depending on the end-use requirement. Where sanded panels are required this shall be specified by the purchaser.

5. TEST REQUIREMENTS

5.1 Sampling a Shipment For Test

5.1.1 **Shipment.** A shipment shall consist of a commercial quantity of particleboard which may consist of mixed grades and thicknesses. The manufacturer shall designate the nominal thickness, nominal density, and grade

which applies to each portion of the shipment which is distinguished by grade or thickness.

5.1.2 Sample for Inspection and Test. A sample for inspection and test shall consist of 1 per cent of the shipment, except that the sample shall not consist of less than 5 panels or more than 10 panels, all taken at random from the shipment. Where the shipment consists of mixed grades and thicknesses, the sample shall include at least two panels of each grade-thickness combination provided the total thus obtained does not exceed ten panels.

5.1.3 Compliance

5.1.3.1 If all the panels in the sample, taken in accordance with Clause 5.1.2, are found by testing to meet the requirements of this Standard, the shipment shall be considered to be acceptable. If three or more panels from the sample fail to meet all the test requirements the shipment shall be considered as failing to meet the requirements of this Standard.

5.1.3.2 If one or two panels from the sample taken in accordance with Clause 5.1.2 fail to meet the requirements of this Standard, a further sample shall be taken consisting of twice the number of panels as the original sample. This second sample shall be chosen at random except that it shall contain not less than four panels from any grade-thickness combination in which the sample previously failed on the first sampling. If all of the additional panels meet the requirements of this Standard, then the shipment shall be considered to meet the requirements of this Standard. If any one of the panels in the second sample fail to meet the requirements of this Standard, the shipment shall be considered as failing to meet the requirements of this Standard, except that in case of shipments of mixed grade-thickness combinations, if the test results from both the first and second samples show all of the failing panels to be confined to a single grade-thickness combination, then only that grade-thickness combination shall be considered as failing to meet the requirements of this Standard.

5.2 Panel Requirements. For an individual panel to comply with the requirements of this Standard, the properties of that panel shall meet all of the test requirements specified in Tables 2 and 3 for the grade, when those properties are measured according to the procedures detailed in Clause 6 of this Standard, and when the moisture condition of the test specimens at the time of test are those specified in Tables 2 and 3 for the particular test.

The different test procedures detailed in Clause 6 require differing numbers of test specimens per panel for different tests, but in each case the instructions for treatment of the test data yields a value for each panel which can be tested for compliance against the specific requirements which are given in Tables 2 and 3 for each Grade. Some tests, such as bending strength and linear expansion, are directional, and significantly different values may be obtained from specimens cut with the long direction of the specimen parallel to the long direction of the particle-board panel than are obtained from specimens cut perpendicular to the long direction of the particle-board panel. From such tests, two values shall be obtained for each panel, and both of these values shall meet the requirements for the Grade shown in Tables 2 or 3.

NOTE: The abbreviation NS (not specified) is used in the Tables whenever the Grade has no requirement for the property.

5.3 Moisture Conditioning Requirements. Both the strength and dimensions of wood particleboard depend on the moisture content of the particleboard at the time of test. For this reason each property specified in this Standard is based on measurements made at some specified moisture content. In Tables 2 and 3, which detail the physical property requirements by grade, the moisture content of the specimens at time of test is specified for each test property. All of these, except measurement of linear expansion, fall into the following three categories:

- (a) **Equilibrium Moisture Content (E.M.C.) at 65 Per Cent Relative Humidity.** To attain this condition, specimens shall be exposed prior to testing in an atmosphere in which the relative humidity is held at 65 ± 2 per cent at some temperature in the range from 62 to 74°F until practical moisture equilibrium is obtained. Practical moisture equilibrium refers to a condition in which the weight of specimens in the controlled humidity atmosphere does not change by more than 0.05 per cent in a 24-hour period;
- (b) **Moisture Content as Shipped.** Those measurements concerned with the dimensional tolerances of particleboard are based on the moisture content at the time it is shipped by the manufacturer. This moisture content must meet the applicable requirement for the grade as shown in Table 2 or 3. Changes in dimensions can be caused by the particleboard losing or gaining moisture during transit to the user. If such changes in moisture content result in the dimensional properties, the density, or the moisture content falling outside of the tolerance limits of this Standard, this shall not be construed as a failure to meet the requirements of this Standard; and
- (c) **Saturated.** The test specimens which are subjected to accelerated aging according to the procedures described in Clause 6.12 shall be tested for strength properties in the soaking wet (saturated) condition which results from exposure to accelerated aging. However, the dimensions of those test specimens shall be measured before exposure to accelerated aging after conditioning according to the requirements of Clause 5.3 (a).

5.4 Test Properties. For each test property, Tables 2 and 3 show the required values for the grade, the appropriate Clause of this Standard by which the property is to be measured, and also the moisture condition the specimens shall have at the time the test is made. The moisture condition shall be interpreted according to the descriptions already given in Clause 5.3.

6. TEST METHODS

6.1 Measurement of Length and Width and Report. The length and width shall be measured from edge to edge across the centre of each sample panel. The nominal dimensions of the panel and the actual measurement of length and width shall be reported to the nearest $\frac{1}{32}$ inch.

6.2 Measurement of Thickness Tolerance

6.2.1 Sampling from Panel. Three test specimens, each at least 6 inches by 6 inches, shall be cut from random locations in each panel. (See also Clause 6.2.4.)

6.2.2 Measurement of Thickness. The thickness of each specimen shall be measured at five points, near each corner and near the centre, to an

accuracy of 0.001 inch. Care shall be taken that the specimen is not deformed when the thickness measurements are taken. An instrument such as a dial gauge indicator which has flat contacting surfaces with a minimum diameter of $\frac{1}{2}$ inch, shall be used. Pressure on the contacting surface shall be not greater than 1 psi or less than 0.25 psi and the instrument shall read to an accuracy of 0.001 inch.

6.2.3 Calculation and Report

6.2.3.1 Average Deviation from Nominal Thickness. The difference between the average thickness of the panel (average of 15 measurements) and the nominal thickness assigned by the manufacturer shall be calculated for each sample panel. These values shall be reported, to the nearest 0.001 inch, as the deviation from nominal.

6.2.3.2 Maximum Deviation From Panel Average. The maximum deviation of any of the individual measurements from the average of the 15 measurements shall be reported to the nearest 0.001 inch for each sample panel as the maximum deviation from panel average.

TABLE 2
REQUIREMENTS FOR BUILDING BOARD

Property	Type I	Type II				Test Clause	Moisture Content at Test
	Grade P	Grade E	Grade F	Grade G	Grade H		
Thickness Tolerance							
Maximum ± Average Deviation from Nominal (inch)	0.030	0.010	0.030	0.015	0.010	6.2	As shipped
Maximum ± Deviation from Panel Average (inch)	0.030	0.005	0.030	0.010	0.005		As shipped
Length and Width Tolerance	+0		+0	+0			
Maximum Deviation from Nominal (inch)	-1⁄8	± 1⁄16	-1⁄8	-1⁄8	± 1⁄16	6.1	As shipped
Squareness Tolerance							
Maximum Deviation from Square (inch per foot)	1⁄64	1⁄64	1⁄64	1⁄64	1⁄64	6.3	As shipped
Straightness Tolerance							
Maximum Deviation from Straight (inch per edge)	1⁄16	1⁄16	1⁄16	1⁄16	1⁄16	6.4	As shipped
Density Tolerance							
Maximum Deviation from Nominal (per cent)							
Over 1⁄2 inch thickness	NS	NS	NS	± 10	± 10	6.5.3	As shipped
1⁄2 inch thickness and under	NS	NS	NS	± 15	± 15	6.5.3	As shipped
Maximum Moisture Content (per cent)	15	8	15	8	8	6.5.4	As shipped
Minimum Modulus of Rupture (psi)	2,000	1,500	1,300	1,300	1,700	6.6	EMC at 65 per cent RH
Minimum Modulus of Elasticity (psi)	280,000	160,000	160,000	160,000	160,000	6.6	EMC at 65 per cent RH
Minimum Internal Bond (psi)	40	40	NS	NS	50	6.7	EMC at 65 per cent RH
Minimum Hardness (pounds)	NS	500	NS	350	500	6.8	EMC at 65 per cent RH
Minimum Screw-Holding Strength (pounds)							
Face	NS	NS	NS	NS	250	6.9	EMC at 65 per cent RH
Edge (For boards 3⁄4 inches and thicker)	NS	NS	NS	NS	NS	6.9	
Maximum Linear Expansion (per cent)	0.5	0.35	0.5	0.5	0.35	6.10	EMC at 50 per cent RH
(50 to 90 per cent RH)							EMC at 90 per cent RH
Minimum Direct Nail Withdrawal, pounds							
(For boards 3⁄4 inch and thicker)	20	NS	NS	NS	NS	6.11	EMC at 65 per cent RH
Properties After Accelerated Aging							
Minimum Modulus of Rupture (psi)	1,160	Not Applicable				6.12	Saturated

TABLE 3
PROPERTY REQUIREMENTS FOR INDUSTRIAL BOARD

Property	Type II		Test Clause	Moisture Content at Test
	Grade R	Grade S		
Thickness Tolerance Maximum $\pm$ Average Deviation from Nominal (inch)	0.005	0.005	0.010	As shipped
Maximum $\pm$ Deviation from Panel Average (inch)	0.005	0.005	0.005	As shipped
Length and Width Tolerance Maximum Deviation from Nominal (inch)	$\pm 1/8$	$\pm 1/8$	$\pm 1/8$	As shipped
Squareness Tolerance Maximum Deviation from Square (inch per foot)	$1/4$	$1/4$	$1/4$	As shipped
Straightness Tolerance Maximum Deviation from Straight (inch per edge)	$1/8$	$1/8$	$1/8$	As shipped
Density Tolerance Maximum Deviation from Nominal (per cent)	± 8 ± 10	± 10 ± 15	± 10 ± 15	As shipped
Maximum Moisture Content (per cent)	8	8	8	As shipped
Minimum Modulus of Rupture (psi)	2,000	1,700	1,700	EMC at 65 per cent RH
Minimum Modulus of Elasticity (psi)	280,000	160,000	160,000	EMC at 65 per cent RH
Minimum Internal Bond (psi)	65	50	40	EMC at 65 per cent RH
Minimum Hardness (pounds)	500	500	350	EMC at 65 per cent RH
Minimum Screw-holding Strength (pounds)	250	200	NS	EMC at 65 per cent RH
Edge	150	100	NS	EMC at 65 per cent RH
Maximum Linear Expansion (per cent)	0.35	0.35	0.5	EMC at 50 per cent RH EMC at 90 per cent RH

6.2.4 Thickness Measurement on Uncut Panels

6.2.4.1 Procedure. In the event that it is desired to check the thickness without cutting the sample panels, four thickness measurements, equally spaced along each long edge, and three thickness measurements equally spaced along each short edge, shall be made, according to the condi-

tions described in Clause 6.2.2 for precision of measurement and psi loading on the pressure foot. The calculation procedure given in Clauses 6.2.3.1 and 6.2.3.2 shall be followed using the average of 14 measurements obtained on the edge of the panel, instead of the average of 15 measurements obtained by sampling within the panel.

6.2.4.2 Compliance. If the average deviation from nominal or the maximum deviation from panel average of any panel calculated from these edge measurements exceeds the tolerance allowed for the Grade specified in Table 2 or 3, that panel shall be considered as failing to meet the requirements of this Standard. If, however, these two calculated deviations fall within the limits for the Grade in Table 2 or 3, this shall not be construed as meaning that the panel meets the requirements of this Standard for thickness tolerance.

6.2.4.3 Report. If the thickness measurement procedure described in Clause 6.2.4 is used, the report shall so state, and the values found for average deviation from nominal and deviation from panel average shall be calculated and reported as described in Clauses 6.2.3.1 and 6.2.3.2.

6.3 Squareness. The squareness of all four corners of every sample panel shall be measured using an accurate carpenter's square (or equivalent tool). The maximum deviation found in each panel shall be reported in terms of the number of $1/8$ th of an inch per foot of run.

6.4 Straightness. Straightness shall be measured as the maximum deviation from a straight line extending from corner to corner on the same trimmed edge. All of the edges of each sample panel shall be measured. The maximum deviation from straightness found in each panel shall be reported to the nearest $1/8$ inch.

6.5 Measurement of Density and Moisture Content

6.5.1 Sampling

6.5.1.1 For the purpose of compliance with this Standard, the density and moisture content requirements of any grade shall be determined by the particleboard manufacturer, on the board at the moisture content as shipped. However, if the physical tests for bending strength (modulus of rupture) are made, the density and moisture content at time of test shall also be measured on a coupon cut from each broken bending-test specimen and reported as moisture content at time of test. These coupons shall be not smaller than 3 inches long by the width of the bending test specimen, and they shall be measured and reported according to the procedures set forth in Clauses 6.5.2, 6.5.3, and 6.5.4.

6.5.1.2 To test for compliance with the moisture content and density requirements of this Standard, three specimens each approximately 3 inches square shall be taken at random from each test panel and measured for density and moisture content according to the procedure given in Clauses 6.5.2, 6.5.3, and 6.5.4. The average values of density and moisture content found for each panel shall be reported.

6.5.2 Determination of Oven Dry Weight. The oven dry weight shall be determined by drying the specimens to constant weight in an oven maintained at a temperature of $220 \pm 4^\circ\text{F}$, and weighing to an accuracy of 0.1 per cent of the dry weight.

6.5.3 Calculation of Density and Report. The length and width of the conditioned test specimens shall be measured to the nearest 0.01 inch,

and the thickness to the nearest 0.001 inch. The oven dry weight shall be measured as described in Clause 6.5.2. The density shall be calculated in terms of pounds per cubic foot, using the following formula:

$$\text{Density (in pounds per cubic foot)} = \frac{\text{oven dry weight (pounds)}}{\text{conditioned volume (cubic feet)}}$$

The density values obtained from each panel shall be averaged and reported as panel density to the nearest 0.1 pounds per cubic foot. The moisture conditioning, if any, of the specimens prior to test shall also be reported.

6.5.4 Calculation of Moisture Content and Report. The moisture content of the test specimens shall be expressed as:

$$\text{Moisture Content (per cent)} = \frac{100(W - F)}{F}$$

where F = the oven dry weight determined according to Clause 6.5.2;
 W = the weight before oven drying.

The moisture content values obtained from each panel shall be averaged and reported to the nearest 0.1 per cent as panel moisture content. The moisture condition of the specimen prior to measurement shall also be reported.

6.6 Determination of Static Bending Strength (Modulus of Rupture) and Static Bending Modulus (Modulus of Elasticity)

6.6.1 General. The modulus of rupture (M.O.R.) and modulus of elasticity (M.O.E.) shall be determined by centre loading of specimens in bending. The M.O.R. shall be the value obtained from the load required to fracture the specimen, and the M.O.E. shall be determined from the linear portion of the stress-strain relationship below the proportional limit. The span used for the test shall be 24 times the nominal thickness of the specimens.

6.6.2 Sampling and Dimensional Measurement of Test Specimens. Three test specimens shall be prepared from each test panel with the long dimension parallel, and three with the long dimension perpendicular, to the long dimension of the panel. If the nominal thickness is $\frac{5}{16}$ inch or under, four samples in each direction shall be taken. The test specimens shall be taken at random locations within the sample panel. Each test specimen shall be three inches in width, if the nominal thickness is greater than $\frac{1}{4}$ inch, and two inches in width, if the nominal thickness is $\frac{1}{4}$ inch or less. The length of each specimen shall be two inches plus 24 times the nominal thickness. The width of the specimen and the test span shall be measured to the nearest 0.01 inch. The thickness shall be measured to the nearest 0.001 inch at the point of contact with the moving crosshead. Three thickness readings shall be taken across the width of the specimen and the average of these readings used to calculate the M.O.R. and M.O.E.

6.6.3 Test Fixtures. The span supports and the centre loading block shall be so constructed that no appreciable compression of the specimen occurs during the measurement. This is generally achieved if the radius of the supports and the loading block is at least $1\frac{1}{2}$ times the thickness of the specimen being tested (see Figure 1). Self-aligning span supports are not required.

The deflection of the specimen shall be measured by means of an indicating dial gauge mounted beneath the centre of the test specimen as shown in Figure 1. Alternatively, the deflection may be measured by automatic testers which record the load as a function of the relative movement of the fixed and moveable crossheads of the test machine, provided that the deflection in the equipment or the compression of the test specimens is not such as to result in a larger value for M.O.E. than would be obtained from the dial gauge mounted beneath the specimen.

6.6.4 Method of Test

6.6.4.1 The bending specimens shall be centered in the span and the load applied continuously throughout the test by a uniform motion of the moveable crosshead of the test machine calculated from the following formula:

$$\text{Speed (inches per minute)} = 0.48t$$

where t = the nominal thickness of the board in inches.
Note: This speed of testing is based on a uniform rate of fibre strain of 0.005 in./in./min. using the formula:

$$\text{Speed} = \frac{0.005 L^2}{6t}$$

Where L is the span used and t is the thickness of the specimen. Since the span is required to be 24 times the thickness, the test speed is directly related to thickness only, as shown in the equation in Clause 6.6.4.

6.6.4.2 The testing machine speed used shall not vary by more than $\pm 5\%$ per cent from that specified for a given test. The crosshead speed shall mean the free-running, or no-load, crosshead speed for testing machines of the mechanical drive type and the loaded crosshead speed for testing machines of the hydraulic loading types.

6.6.5 Load-Deflection Curves. Load-deflection curves shall be obtained up to the proportional limit for all bending tests. Load and moving deflection values shall be recorded with sufficient frequency as to obtain five or more load-deflection values up to the proportional limit for each specimen.

The deflection values shall be read to the nearest 0.001 inch and the load values to a precision of approximately one per cent of the load values. The load values shall be plotted graphically against the corresponding deflection values and the "best fit" slope of the linear portion of the load-deflection curve (below the proportional limit) shall be determined to three significant figures.

6.6.6 Calculation and Report

6.6.6.1 The bending properties shall be calculated for each test specimen from the following formula:

$$\text{Modulus of Rupture (psi)} = \frac{3PL}{2bd^3}$$

$$\text{Modulus of Elasticity} = \frac{L^3}{4bd^3} \cdot \frac{P}{\Delta}$$

where b = width of specimen in inches;

d = average thickness of specimen in inches;

L = length of span in inches;

P = maximum load in pounds (failing load);

Δ = slope of the load deflection curve in pounds/inch.

6.6.6.2 The M.O.R. and M.O.E. values for the three or four test specimens shall be averaged from each cutting direction of each panel. The average values shall be reported, in psi, for each cutting direction of each sample panel as M.O.R. or M.O.E. (parallel), M.O.R. or M.O.E. (cross), expressed to three significant figures.

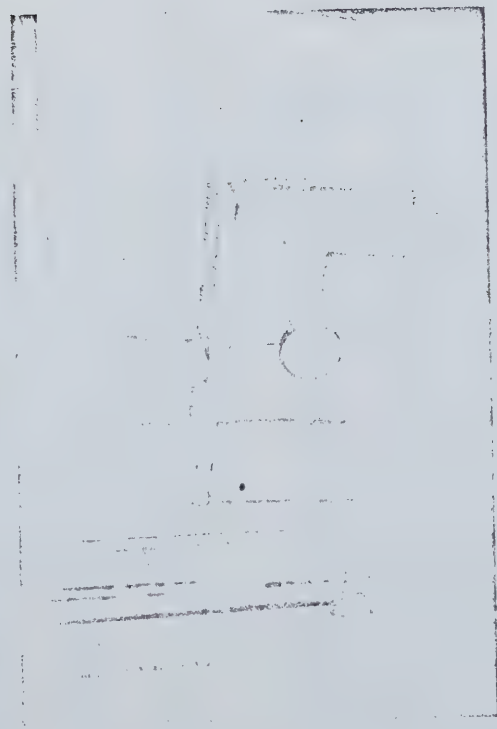


FIGURE 1
STATIC BENDING TEST ASSEMBLY

6.7 Measurement of Internal Bond Strength

6.7.1 Sampling and Preparation of Test Assemblies

6.7.1.1 The test for internal bond strength (tensile strength perpendicular to the plane of the board) shall be made on six specimens cut from random locations in each sample panel. These specimens shall be cut square, 2 inches by 2 inches, and the area of the specimen shall be determined from measurements made to the nearest 0.01 inch.

6.7.1.2 Loading blocks (2 inch by 2 inch) of steel or aluminum alloy shall be adhesive bonded to each surface of each test specimen in such a way that the strength of the glue line is substantially stronger than the strength of the material being tested.

Note: The most fool-proof adhesive for this test is a polyamine catalyzed epoxy resin. This epoxy adhesive cures at room temperature, and after testing, the blocks are cleaned by heating them to soften the glue line and prying off the residue of the test specimen. The adhesion of this epoxy to metal is so close to traces of oil or grease on the metal. Also with this adhesive care must be taken that excess adhesive from the upper glue line does not run down the sides of the specimen and form adhesive "bridges" between the top and bottom loading blocks. This addition of sticky material in an amount sufficient to convert the epoxy mixture into a plastic paste (a 3 per cent by weight) will greatly reduce the tendency to run and form bridges. Other adhesives such as hot-melt cements or water-based adhesives may be used, provided that the conditions of gluing do not significantly alter the moisture distribution in the test specimen, or provided that glued assembly is reconditioned to equilibrium in the conditions specified in Clause 5.3 (a) prior to testing.

6.7.2 Test Procedure

6.7.2.1 Test fixtures for internal bond test are shown in Figure 2. These consist of loading fixtures which engage the top and bottom loading blocks, and which are in turn connected to the test machine by means of universal joints.

Note: These universal joints should be located as near to the loading fixtures as possible and not more than five inches away from the centre of the test specimen.

6.7.2.2 The loading of the test specimen shall be by separation of the loading fixtures until failure occurs. The load shall be applied continuously throughout the test at a uniform rate of motion of the crosshead of 0.08 inches per minute. As the load is applied, care shall be taken to ensure that the specimen is held perpendicular to the direction of loading and that the centre of load passes through the centre of the test specimen.

6.7.2.3 If any of the test specimens fail at or near the surface of the test specimen in such a manner that any glue line failure is visible in the plane of fracture (failure of the adhesive to stick to the wood or the metal), the results of that specimen shall be discarded, and a replacement specimen taken from the same panel. The results from shallow failures in the particleboard in which there is no evidence of glue line adhesion failure shall not be discarded.

6.7.3 Calculation and Report. The maximum load obtained from the test described in Clause 6.7.2 shall be converted to psi using the measured dimensions of the test specimen. The results of the six tests shall be averaged to the nearest psi and reported as the internal bond strength of the panel.

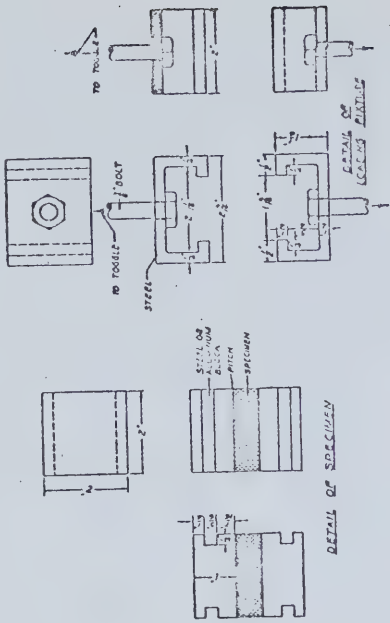


FIGURE 2
DETAIL OF SPECIMEN AND LOADING FIXTURE FOR
TENSION TEST PERPENDICULAR TO SURFACE

6.8 Measurement of Hardness

6.8.1 Sampling and Preparation of Test Assembly. Three test specimens shall be required from each test panel, each nominally 3 inches by 6 inches, and sampled randomly from the panel. In addition, dummy

pieces of the same size are required for use as a back-up board. These dummy pieces shall be taken from the same panel, and two or more of them laminated together to form a block approximately the size of the test specimen and at least one inch thick. One dummy piece shall be prepared for each test specimen.

6.8.2 Method of Test. The modified Janka Ball test, with a ball 0.444 inch in diameter, shall be used. Two penetrations shall be made on each of the two flat faces of each test specimen. The location of the points of penetration shall be at least one inch from the edge, and so located on the surface that any penetration measurement from either side of the specimen will not affect any other penetration measurement. During the test, the test specimen shall be supported on the back-up assembly described in Clause 6.8.1, and when the specimen is reversed for measurements on the second face, the back-up assembly shall be reversed. The load shall be applied continuously throughout the test at a uniform rate of motion of the moving cross-head of 0.25 inch per minute.

The load at which the ball has penetrated to one-half its diameter, as determined by an electric circuit indicator or the tightening of the collar against the specimen, shall be the measure of hardness.

6.8.3 Calculation and Report. The twelve hardness measurements obtained on the three specimens from each panel shall be averaged and reported to the nearest pound as the hardness for each panel tested. When one face is different from the other, the data from each face shall be reported separately.

6.9 Measurement of Screw-Holding Strength (Screw Withdrawal Resistance)

6.9.1 Sampling and Test Assembly Preparation

6.9.1.1 General. The specimens for measurement of either face or edge screw withdrawal shall be cut from randomly selected positions in the sample panels. Every care shall be taken to ensure that both the lead holes and the inserted screws are at right angles to the surface being tested.

6.9.1.2 Withdrawal Perpendicular to the Plane of the Panel (Face Screw-Holding Strength). For each panel, three test assemblies, each 3 inches by 6 inches, shall be required. The thickness of these specimens shall be at least 1 inch, with two or more 3-inch by 6-inch pieces glued together if necessary to achieve the minimum thickness, using a flexible adhesive such as a rubber-base contact cement.

Three screws shall be located at mid-width of the specimen, one at centre length and the other two 1½ inches from the ends. At each of these positions lead holes shall be drilled to a depth of ¾ inch, using a ¾ in. drill. One sheet metal screw, (1½ inch long Type A No. 10) shall be threaded into each pilot hole to a depth of ¾ inch. The screws shall be inserted into the specimens immediately before the test for withdrawal resistance is made.

6.9.1.3 Withdrawal Perpendicular to the Edge of the Panel (Edge Screw-Holding Strength). Edge screw-holding test on boards thinner than ¾ inch nominal thickness are not required by this Standard. The specimen size shall be 2½ inches by 4½ inches by the thickness of the panel. In order to distinguish any directional properties, three such specimens shall be cut with the long direction of the specimen parallel to the long dimension of the panel, and three such specimens shall be cut perpendicular to the

long dimension of the panel. One screw shall be positioned on one long edge of the specimen, 1½ inches from the end of the specimen and in the centre of the board thickness. The other screw shall be positioned on the other long edge of the specimen, 1½ inches from the other end of the specimen.

Lead holes shall be drilled at the specified locations to a depth of ¾ inch, using a ¾ in. drill, and 1½ inch Type A No. 10 sheet metal screws threaded into the specimen to a depth of ¾ inch. The withdrawal test shall be made immediately after the screws are inserted.

Notes: 1. In some applications of particleboard, several thicknesses of particleboard may be laminated together, and it may be desirable to obtain a measure of edge screw withdrawal resistance on such a laminate. In such a case the laminate should consist of an odd number of plies, and the screws should be inserted at the mid thickness of the entire laminate.

2. On boards thinner than ¾ inch, it may be desirable to perform edge screw holding measurements using smaller screws and lead holes than those just described. For such test the end user and manufacturer should agree on the type of screws, the pilot hole size, and depth of insertion. In such cases, the clear details of the test procedure given here should be followed, and the exceptions noted in the report.

6.9.2 Method of Test for Screw Withdrawal

6.9.2.1 The test assembly for screw withdrawal shall be as shown in Figure 3. The specimen holding fixture shall be rigidly attached to the lower platen in such a way that the under faces of the top part of that fixture are perpendicular to the direction of test and the fixture is also centered in the direction of test. The upper fixture shall be attached to the upper platen of the testing machine through a universal joint connector as shown in Figure 3. The design details of the upper and lower fixtures are shown in Figure 4.

6.9.2.2 The test specimens shall be inserted in the lower fixture of the test assembly in such a manner that the screw protrudes vertically through the slot in the upper face of the fixture and is also centered on the line of test.

6.9.2.3 The head of the screw shall then be engaged into the stirrup of the upper test fixture, and the load applied by a uniform motion of the moving crosshead at a rate of 0.6 inch per minute. The maximum load in pounds reached during the withdrawal of the screw is the screw-holding strength for that test.

6.9.3 Calculation and Report

6.9.3.1 Face Screw-Holding Strength. The nine values obtained from each test panel shall be averaged and reported to the nearest pound as the face screw-holding strength for each panel.

6.9.3.2.1 Parallel

The six values obtained from the three specimens cut with the long direction parallel to the long direction of the board shall be averaged, and reported to the nearest pound as edge screw-holding strength (parallel) for each panel tested.

6.9.3.2.2 Cross. The six values obtained from the three specimens cut with the long direction perpendicular to the long direction of the board shall be averaged, and reported to the nearest pound as edge screw-holding strength (cross) for each panel tested.

6.10 Measurement of Linear Expansion

6.10.1 Sampling and Specimen Preparation

6.10.1.1 Four specimens shall be cut at random from each test panel, two cut parallel to the long dimension of the panel and two cut perpendicular to the long dimension of the panel. The specimen size shall be 3 inches wide by a minimum of 6 inches long, preferably 12 inches long.

6.10.1.2 Reference aids shall be established on the surface of the test specimen approximately 1 inch from each end and at mid-width, by such means as driving brass nails into the specimens, or by placing a drop of epoxy resin or sealing wax on the surface and allowing it to harden. These reference aids shall be scored with a reference line at right angles to the specimen or centre punched to provide exact datum lines or points for measurement.

6.10.2 Method of Test

6.10.2.1 The specimens shall be conditioned to practical equilibrium in an atmosphere having a relative humidity of 50 ± 2 per cent and a controlled temperature in the range from 62 to 74°F.

6.10.2.2 After conditioning, the distance between the reference points (reference length) shall be measured to a precision of 0.001 inch and the specimen weighed to an accuracy of 0.1 per cent. This measurement of length may be made by any convenient means of sufficient precision such as mounting a one-inch dial gauge on an extension arm, or by affixing two sharpened points to the side of the jaws of a vernier caliper. During this and subsequent measurements the specimen shall be held flat against a plane surface (clamped if necessary) to remove any warp or twist in the specimen.

6.10.2.3 After the reference measurements are made and recorded, the specimens shall be conditioned to practical equilibrium in an atmosphere having a controlled temperature in the range from 68 to 72°F, and average relative humidity of 90 per cent and sufficiently well controlled that condensation of moisture does not occur in the chamber.

Notes: 1. With a dry bulb temperature in the vicinity of 70°F a relative humidity of 90 per cent is obtained from a wet bulb depression of 2°F below the dry bulb temperature.

2. The term "practical equilibrium" used in Clause 6.10.2.3 is defined as the condition in which the weight of the test specimen is not changing by more than 0.1 per cent per day. Depending on the nature of the particleboard and the efficiency of circulation in the conditioning chamber, attainment of practical equilibrium at 90 per cent RH may require from two weeks to six weeks exposure.

3. In ASTM Standard D1037, Methods of Evaluating the Properties of Wood-Base Filler and Particle Panel Materials, the procedure for measurement of linear expansion is based on measurement of the overall length of the specimen rather than on a measurement between two reference marks on the surface of the specimen. This alternative measurement technique will yield the same or slightly higher values than the measurement technique described in Clause 6.10.

6.10.2.4 Once practical equilibrium has been obtained, the specimens shall be measured to obtain the increase in length between the reference points. The specimens shall then be weighed to an accuracy of 0.1 per cent and oven dried to constant weight in an oven maintained at 220 ± 4 °F.

6.10.3 Calculation and Report

6.10.3.1 The percentage increase in length between the reference points found to result from the change in E.M.C. between 50 per cent and 90 per cent relative humidity shall be calculated for each specimen. Two

TEST ASSEMBLY—RESISTANCE OF NAILS AND SCREWS TO DIRECT WITHDRAWAL

FIGURE 4

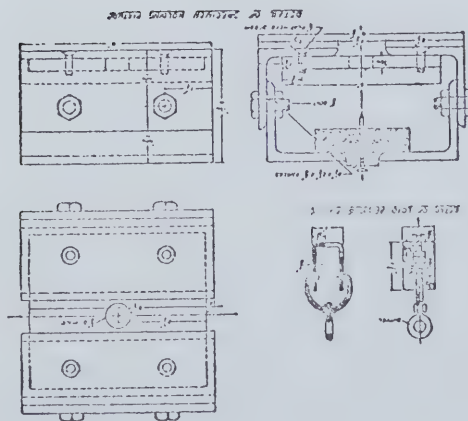
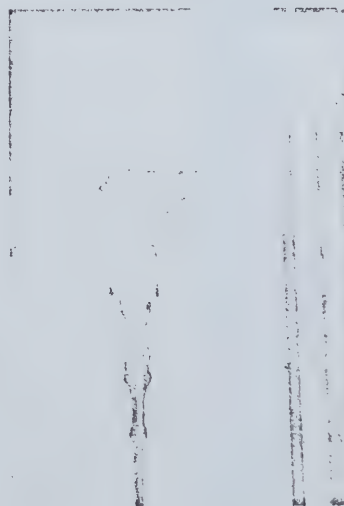


FIGURE 3



values obtained for each direction of each panel shall be averaged and reported as linear expansion (parallel) and linear expansion (cross), expressed to the nearest 0.01 per cent.

6.10.3.2 The moisture content of each specimen for each of the two equilibrium humidity conditions shall be calculated from the weight data. The four values obtained from each panel shall be averaged and reported as moisture content (50 per cent RH) and moisture content (90 per cent RH), expressed to the nearest 0.1 per cent, for that panel.

6.11 Measurement of Nail Withdrawal Resistance

Note: This test measures the resistance of nails to direct withdrawal in a direction perpendicular to the surface of the particleboard. The minimum value in Table 2 is a performance requirement rather than a description of an inherent property of the particleboard.

6.11.1 **Sampling and Specimen Preparation.** Three specimens each 3 inches in width and 6 inches long shall be cut from random positions in each test panel. The nails shall be 2½-inch common nails (Canadian 7D). Three such nails shall be driven into each specimen at mid-width, with one in the centre of the length and the other two 1½-inches from the ends. The nails shall go completely through the thickness of the specimen but at least ½ inch of the head end of the nail shall project above the surface of the specimen, and they shall be driven perpendicular to the surface.

6.11.2 **Method of Test.** The test fixtures for this test shall be those shown in Figures 3 and 4. For each test, the nail shall be centered in the slot of the lower test fixture and the head of the nail engaged in the slot of the upper test fixture. The load shall be applied by separation of the heads of the test machine at a uniform rate of 0.06 inches per minute. The maximum load in pounds developed during the withdrawal of the nail shall be the nail withdrawal resistance.

6.11.3 **Calculation and Report.** The results of the nine tests made per test panel shall be averaged and reported as the nail withdrawal resistance, expressed to the nearest pound, for each panel tested.

6.12 Bending Strength After Accelerated Aging

Note: The accelerated aging test is a treatment applied to particleboard specimens to assess the durability of the adhesive bond in particleboard made with a phenol-formaldehyde resin binder. It is based on a exposure of the particleboard specimens to boiling water for a period of 2 hours and cooling the specimens in water at room temperature (68 ± 6°F) prior to test.

6.12.1 **Sampling and Method of Test.** The sampling, conditioning, and test procedure shall be the same as that described in Clause 6.6 except that after measurement of the dimensions the bending specimens shall be submerged in boiling water for not less than 2 hours and then immediately testing for bending strength. The specimens shall also be examined after boiling for any signs of deterioration such as delamination of the board, the formation of loosely bonded surface particles, or non-uniform thickness swelling along the length of the specimen. Any such deterioration shall be noted in the report.

6.12.2 **Calculation and Report.** The modulus of rupture shall be calculated for both the parallel and cross directions of the particleboard as described in Clause 6.6 except the breaking loads obtained on the wet specimens shall be used. The calculated values for the modulus of rupture

shall be based on the original thickness of the board measured after conditioning in accordance with Clause 5.3 (a). The values shall be reported as M.O.R. after accelerated aging (parallel) and M.O.R. after accelerated aging (cross).

7. MARKING

7.1 Every panel which is made to meet all of the requirements of Grade P in Table 2 shall be marked by the manufacturer with the symbol P100 in such a manner that the marking will not be obliterated by light, moisture, or abrasion during normal shipment and use.

APPENDIX A

END USE APPLICATIONS OF WOOD PARTICLEBOARD

NOTE: This Appendix is not a mandatory part of this Standard.

A1. GENERAL

A1.1 Table A1 provides a listing of the Grades of particleboard (as defined in the body of this Standard) which are recommended for particular end use applications. These recommendations are based on present-day practice.

TABLE A1
GRADE RECOMMENDATIONS FOR VARIOUS END USE
APPLICATIONS OF WOOD PARTICLEBOARD

End Use Application	Recommended Grade	Category	Type
Underlayment	E	Building	II
Wall sheathing	F	Building	II
Interior Cladding	G	Building	II
Cabinets, Vanities	H	Building	II
Exterior Cladding, Fences, Screens, Roof Sheathing, and Sub Flooring	P	Building	I
High Quality Furniture Core	R	Industrial	II
Medium Quality Furniture Core, Countertops, etc.	S	Industrial	II
Wall Panel Core	T	Industrial	II

NOTES: 1. In building applications, the use of a particular product may be governed by national or local building codes.
2. In industrial applications, the user may wish to use products having higher strength properties than the type of product described by the highest grade given for that category, for reasons such as greater convenience in manufacture. This is a subject for negotiation between the manufacturer and purchaser.

APPENDIX B

TEST METHOD FOR
SURFACE STRENGTH OF PARTICLEBOARD

NOTE: This Appendix is not a mandatory part of this Standard.

FOREWORD

This test method for surface strength of particleboard is proposed for future incorporation into this Standard. Since the test method is new, the required minimum values for any particular application are not known although tests carried out on representative samples of Canadian particleboard showed values ranging from about 75 psi to about 300 psi. Any use of the results of this test for purchase specification purposes falls outside of this Standard, and is a matter for agreement between the purchaser and the supplier.

B1. SAMPLING

B1.1 The surface strength test shall be carried out on both faces of the particleboard. Six test specimens, each 3-inch by 3-inch, shall be taken at random from the test panel, and marked in such a way that three can be tested on one face and three can be tested on the opposite face.

B2. TEST ASSEMBLY PREPARATION

B2.1 The minimum thickness of specimen required for this test is 1/2 inch. It is therefore necessary to laminate the test specimen to one or more pieces of particleboard as required to build the total thickness to 1/2 inch or more, using a rigid-setting adhesive such as urea formaldehyde resin adhesive.

B2.2 The metal cylinder used for the test shall be glued in the centre of the surface of the laminated test specimen, using an epoxy adhesive or any other suitable adhesive. The dimensions of this cylinder shall be 1.125 inches in diameter (one square inch cross-section) and the length shall be approximately one inch. One face of this cylinder shall be smoothly finished and glued, while a threaded hole shall be placed in the exact centre of the opposite face and also aligned perpendicular to the gluing face. Figure B1 shows the manner in which the metal cylinder is glued to a particleboard specimen. The lower test assembly shows an assembly with the squeeze-out bead of the adhesive in place. This excess adhesive must be completely removed before the assembly is tested, either before or after the glue has hardened.

NOTE: An epoxy adhesive has been found suitable for this test. The type of adhesive recommended for this application is an epoxy with a polyamine hardener, extended with fillers (amounts (20-50 per cent) of an inert filler such as titanium dioxide. Such a mix is then joined to provide a good metal to wood bond while also being readily removed from the metal blocks by heating the blocks and prying off the glue-wood residue. The concrete or dehydrated cement applied by a hot melt technique may also be used, but the condition of gluing are more critical than are required for the gluing operation for the testing of internal bond. The criterion for a satisfactory gluing operation is that the tested specimen shall show 100 per cent wood failure (no glue failure).

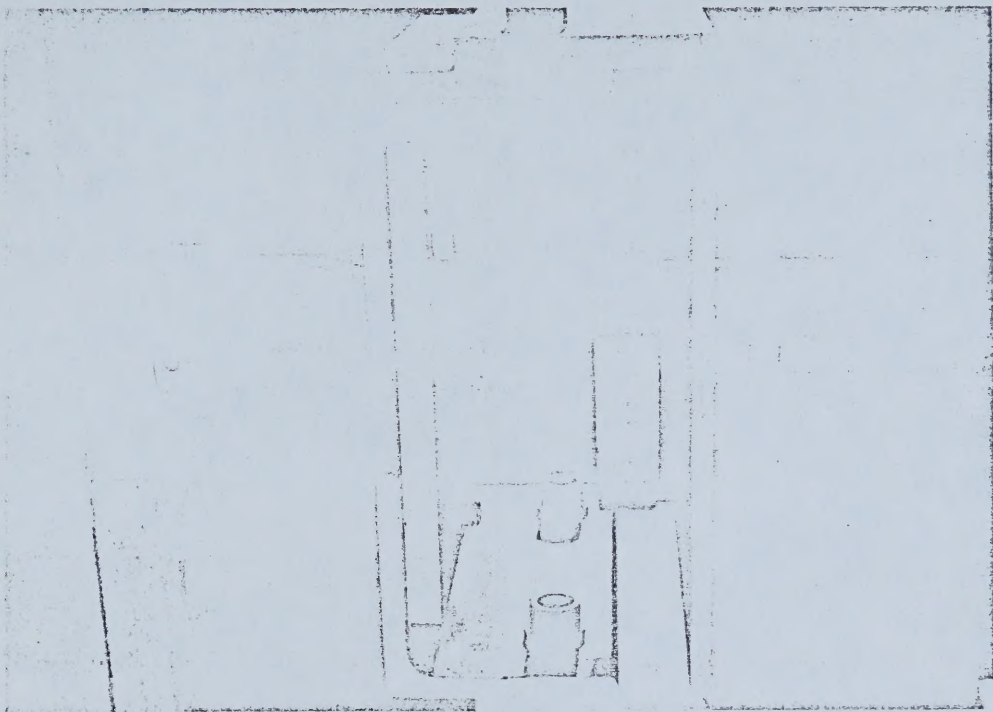


FIGURE B1
SURFACE STRENGTH TEST APPARATUS

B3. TEST FIXTURES

B3.1 The test fixtures required for this test are shown in Figure B1. In essence, the lower test fixture consists of a $\frac{1}{4}$ -inch steel plate mounted in a

plane exactly perpendicular to the direction of test. The mounting shall be such that this plate is held rigidly and there is at least $2\frac{1}{2}$ inches clearance beneath it to permit entry of the test assembly. This plate shall have a hole drilled in the exact centre which is $\frac{1}{16}$ inch larger than the diameter of the metal cylinder. The upper arm of the test machine shall have a threaded means of engaging the threaded hole in the top of the test cylinders so as to apply a force which will remove the metal cylinder in a direction perpendicular to the surface of the particleboard. A self-aligning joint (universal joint) is required in the upper arm of the test fixture.

B4. TEST PROCEDURE

B4.1 Insert the test assembly into the test fixture as shown in Figure B1, engage the threaded portion of the upper arm into the threaded hole of the cylinder and rotate the specimen to engage the thread and bring the particleboard specimen up tight against the lower face of the steel plate. Examine the contact area to make sure that the surface of the particleboard is in uniform contact with the steel plate all around the perimeter of the hole. Apply the load by separating the upper and lower heads of the test machine at a uniform rate of 0.1 inches per minute. The maximum load required to separate the metal cylinder from the face of the particleboard is the surface strength of the specimen. Since the area of the test surface is one square inch, this maximum load is also the surface strength expressed in psi. If the broken glue joint shows any glue failure, the result from that test shall be discarded, and an additional sample taken to replace it.

B5. CALCULATION AND REPORT

B5.1 Average the three surface strength measurements for each face of the particleboard and report as the surface strength to the nearest psi, for each panel sampled.

